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GEOGRAPHICAL REVIEW

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OUR CONTRIBUTORS

MISS BOYD explored the waters and coasts off a part of Franz Josef Land in 1926, in the motorship *Hobby*. Again in 1928 she chartered the same vessel and participated in the prolonged search in Arctic seas for Captain Roald Amundsen. In the *Veslekari*, 1931, she conducted an expedition to East Greenland, photographing the topography of the region described in the present article, collecting plant specimens, and studying ice conditions.

MR. SHIPPEE was co-leader with Lieutenant George R. Johnson of the Shippee-Johnson Peruvian Expedition of 1931. To the January, 1932, number of the *Geographical Review* he contributed "The 'Great Wall of Peru' and Other Aerial Photographic Studies by the Shippee-Johnson Peruvian Expedition."

DR. COLTON is professor of zoölogy at the University of Pennsylvania and Director of the Museum of Northern Arizona at Flagstaff. He has lived in northern Arizona for the past six years, where his work has included the pursuit of an archeological survey, which he began in 1916.

DR. NORIN, chief geologist of Sven Hedin's "Sino Swedish Expedition," has made journeys in various regions of High Asia. He has paid special attention to problems of past glaciations. One of his recent studies is "The Basin of Bagrash-Köll" in *Geografiska Annaler* (Nos. 2 and 3, 1931). This season Dr. Norin has been working in northwestern Tibet.

DR. STEVENSON is associate professor of anatomy, Peiping (Peking) Union Medical College, Peiping, China. He has been for fifteen years resident in China, actively engaged in research in physical anthropology. He has traveled extensively through mountainous regions of Shansi and along the Mongolian and Tibetan borders of China in connection with studies of the separate ethnic elements making up the present-day Chinese racial complex.

MR. BISHOP is associate curator of the Freer Gallery of Art of the Smithsonian Institution. From his headquarters in Peiping he has for many years been carrying out archeological investigations. To the *Geographical Review* he has contributed "The Geographical Factor in the Development of Chinese Civilization" (Vol. 12, 1922) and "The Historical Geography of Early Japan" (Vol. 13, 1923).

PROFESSOR HOBBS is professor of geology in the University of Michigan. In the broad sphere of his interests special mention may be made of his work in seismology and glaciology, and, in connection with the latter, certain aspects of meteorology. He organized the Greenland Expeditions of the University of Michigan and was leader of the first three expeditions (see "The First Greenland Expedition of the University of Michigan," *Geogr. Rev.*, Vol. 17, 1927). His numerous books include "The Glacial Anticyclones" (1926) and "Exploring About the North Pole of the Winds" (1930).

PROFESSOR JOHNSON is professor of physiography in Columbia University. His numerous writings include "Shore Processes and Shoreline Development" (1919), "Battlefields of the World War" (*Amer. Geogr. Soc. Research Ser. No. 3*, 1921), "The New England-Acadian Shoreline" (1925), and "Stream Sculpture of the Atlantic Slope" (1931).

DR. WRIGHT, librarian of the American Geographical Society and in charge of the Society's New England studies, is editor of the "Atlas of the Historical Geography of the United States."

SIR HUBERT WILKINS has contributed to the *Geographical Review* "The Flight from Alaska to Spitsbergen, 1928, and the Preliminary Flights of 1926 and 1927" (October, 1928), "The Wilkins-Hearst Antarctic Expedition, 1928–1929" (July, 1929), and "Further Antarctic Explorations" (July, 1930), and to "Problems of Polar Research," *Amer. Geogr. Soc. Special Publ. No. 7*, 1928, the article "Polar Exploration by Airplane."

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Atlas of the Historical Geography of the United States. By C. O. PAULLIN. With 166 plates comprising over 620 separate maps. xiv and 145 pages; text; index. Published jointly by the American Geographical Society and the Carnegie Institution of Washington and distributed by the Society. 1932. $15.00.

Separate Maps published in the *Geographical Review* and the *Bulletin of the American Geographical Society*, the majority in color. 25 cents each. A list will be sent upon request.

THE
GEOGRAPHICAL REVIEW

VOL. XXII OCTOBER, 1932 NO. 4

FIORDS OF EAST GREENLAND

A PHOTOGRAPHIC RECONNAISSANCE THROUGHOUT THE FRANZ JOSEF AND KING OSCAR FIORDS

Louise A. Boyd

[With separate map, Pl. III, facing p. 560]

MILE-HIGH walls of rock form much of the coast of East Greenland in the region of Franz Josef Fiord. A great plateau capped with ice here ends in spurs and scarps, and its border is traversed by some of the profoundest fiords known in the world. From the ice cap glaciers descend to the heads and to the foot of the walls of the fiords and show a variety of form and of glacial action probably unsurpassed. In many places the rock is brilliantly colored and presents an aspect even more striking than the colored rocks that form portions of the walls of the Grand Canyon of Arizona. Add a sea that is dotted with icebergs or fringed with pack ice on whose outer border are great floes that have come from the polar basin north of the Spitsbergen region, and we have a picture of such majesty and on so vast a scale that no explanation need be given by any explorer for wishing to visit or revisit such a scene.

Between the ice-capped plateau at the top of the fiord walls or at the heads of the fiords on the landward side and the belt of sea ice that clings to the shore or bounds the seaward horizon is another world—the strip of ice-free land that forms the fiord walls, the stream flats that are locally developed, and the terraces and alluvial fans that fringe the coast in places. This is the habitable strip of East Greenland. Here are the musk oxen, hares, foxes, wild flowers, grass, and the habitations of men. The ice-free coastal strip is the human part of East Greenland, the *pied-á-terre* of the hunter, the wireless operator, the visitor, the explorer, a stake for the claims of governments.

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FIG. 1

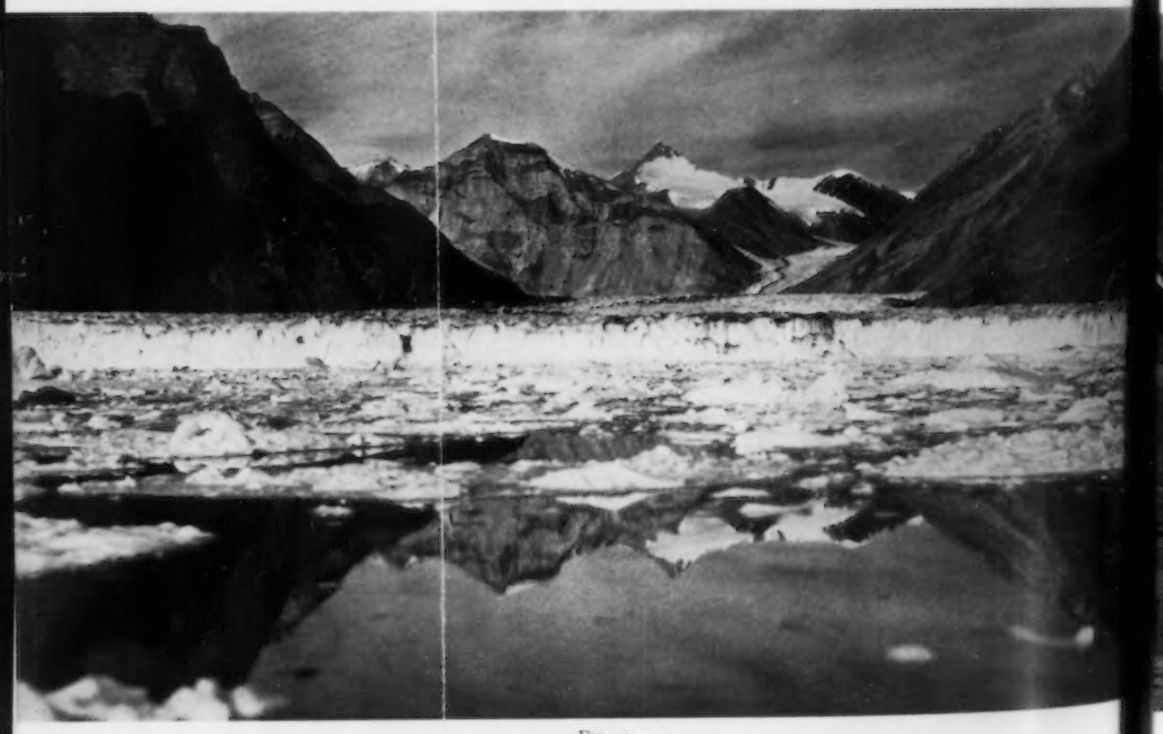

FIG. 2

FIG. 1—The head of Franz Josef Fiord with Nordenskiöld Glacier. July 31, 1931.
FIG. 2—The head of Franz Josef Fiord and Nathorst Peak, 8480 feet. July 31, 1931.

FIG. 3

FIG. 4

FIG. 3—The head of Kjerulf Fiord with "J. F. B." Mountain. August 2, 1931.
FIG. 4—The left valley from its junction with the right valley, Kjerulf Fiord. August 2, 1931.

After several voyages in the vicinity of Franz Josef Land and Spitsbergen, I decided to enlarge my knowledge of the Arctic regions by a visit to East Greenland. I sought to examine every inlet and sound in the Franz Josef and King Oscar Fiord areas. If time permitted, I planned to go south to Scoresby Sound, visit the Danish settlement and the fiords of that area also. It seemed to me possible to make a contribution to our knowledge of the geography of the region by making of it a photographic reconnaissance.[1] The greater part of the program was carried out. I obtained several thousand photographs, the entire collection of which I have donated to the American Geographical Society. A number are reproduced in this article. The value of photographs made for the purpose from carefully selected stations is illustrated by the map, Plate III (facing p. 560), of the newly discovered connection between Kjerulf and Dickson fiords. This map, as explained later, was constructed by the American Geographical Society from my photographs and notes.

Jan Mayen

The expedition left Aalesund, Norway, on the *Veslekari*, July 1, 1931.[2] We went north close inshore along the coast to the Lofoten Islands. After leaving the coast we steered a fairly direct course toward Jan Mayen Island. The wireless station in Jameson Bay reported good weather, though we could advance but slowly in view of our uncertain position and the impenetrability of the fog. On July 9 the snow-capped summit of Mt. Beerenberg appeared through a hole in the dense fog that enveloped us. Beerenberg is an extinct volcano that rises some 8000 feet almost directly out of the sea. Ice pours in lava-like forms into its crater and down its sides, many of its glaciers reaching sea level. In full sunshine one sees the mountain in all its grandeur, dominating the island, but an unforgettable impression was our first view after anxious days and watchful peering through a thick fog curtain.

Jan Mayen belongs to Norway. The island has a wireless and meteorological station on a bluff overlooking Jameson Bay. Three men are its only inhabitants. Knowing that few ships stop there I had offered to take provisions and mail. Fortunately I was able to send the good news by wireless that I had mail for each one of the three men. It is true that letters are read over the air, rather long letters at that, but what a difference to receive a letter in a closed

[1] I have specialized in photography of the Arctic regions for geographical applications, and on my expeditions all photographs—still, color, or cinema—are taken by myself.

[2] The S. S. *Veslekari*, a stout wooden vessel of 154.25 net tonnage that I chartered for the expedition had been specially built for the polar seas, and her skipper, Captain Paul Lillenes, had had 31 years' experience in these waters. My guide, F. J. de Gisbert, also had had 25 years in the Arctic. A wireless operator and a crew of 14 completed the personnel, and my party also included six guests among whom was Mr. R. H. Menzies, who contributes the botanical report, Appendix I.

envelope in the familiar handwriting of those at home on the mainland! Ten months had elapsed since the men had had that experience. Supplies of all kinds have of course to be brought from Norway and in quantities to last for a year or more. We found on our arrival that

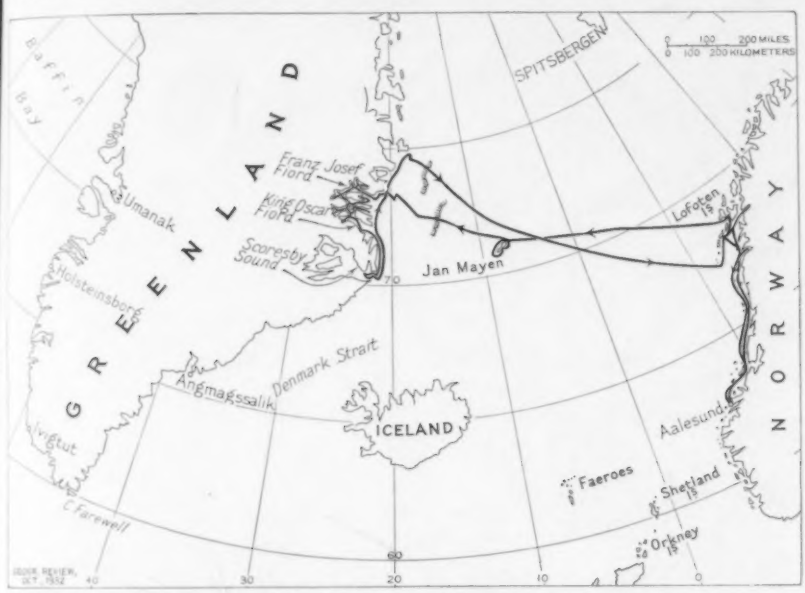

FIG. 5—Map showing the route of the *Veslekari* from Aalesund to East Greenland and return, 1931. The edge of the ice belt along the coast as entered, July 13, and left, August 20, is indicated. For the route through the fiords see the inset on Plate III. Scale 1 : 30,000,000.

the greatest need was for potatoes: Christmas had been celebrated by eating the last of the store.

In the company of Mr. Olonkin, chief of the station, I crossed the island to the north lagoon, passing through the "Valley of Death" where still remain the huts of the Austrian expedition that wintered on the island during the first International Polar Year, 1882–1883. One of the wooden huts is still erect, and so, too, are the crosses close by that mark the graves of some of the members of the expedition. The cliffs back of the site are vast bird rookeries, and the shore of the adjacent bay was covered with a quantity of driftwood.

On leaving the island, July 12, we spent some time off the east coast trying to harpoon bottle-nosed whales—without success in spite of their great numbers. After circling the island we set our course northwest. The white summit of Mt. Beerenberg could still be seen nearly a hundred miles out.

Crossing the Ice Belt

About 150 miles northwest of Jan Mayen on July 12 at 10 p. m. we encountered our first iceberg, a tabular berg of substantial size.

On its flat smooth surface was a large flock of kittiwakes. We entered pack ice on July 13 at 7 a. m. in latitude 72° 22′ N., longitude 14° 10′ W. There was very little slush, and floes of good size surrounded us, a notable contrast to my previous Arctic experiences where I encountered slush ice for many hours of steaming before coming to sizable floes. Few floes showed any signs of recent storms. Rarely while in the pack did we have large open-water pools. For the most part the sea was covered pretty solidly with ice. Soon we passed into the most formidable portion of the belt of ice that borders the Greenland coast—heavy fields of polar ice, i.e. ice several years old that has come down from the polar basin.

FIG. 6—The *Veslekari* in the pack ice.

On July 15 we could clearly see the coast that was our goal. Not so our "lane to Greenland," a channel between the ridged hummocks 20 feet wide and filled with great blocks of ice. At one time the ice was eight feet above the stern railing, and for a few hours we were beset. More fortunate, however, than the *Gustav Holm* of Lauge Koch's expedition, which we passed to the southward, we were able to extricate ourselves, favored by a southward-setting current, and aided by the tireless efforts of the crew in warping the boat and opening lanes and pockets with dynamite. On July 17, after four days in the ice, we reached the east coast of Greenland just south of Cape Broer Ruys, Hold with Hope (Fig. 7), and anchored the *Veslekari* to the ice, the first ship to reach the east coast of Greenland in the summer of 1931. While in the ice we exchanged wireless messages with Dr. Koch on the *Godthaab* and Dr. Adolf Hoel on the *Polarbjørn*.

Captain Lillenes considered this one of the two most difficult crossings of his numerous trips to East Greenland. Fortunately we had no fog and no rain after entering the ice, but brilliant sunshine. And further compensation lay in the beauty of the ever-changing scene: the varied sculpture of the great marble-like blocks of crystalline ice; the blue of the ice above, the deeper blues of the frozen pools on the surface of the floes and of the cracks in the ice, and yet another blue, sometimes deep purple, of the ice below the surface.

We estimated the width of the pack ice to be 140 miles where we crossed it. Large floes lay off the coast and in places were piled up against the land. It took us a half hour in the launch to wind our way through leads to the shore. To the north of our landing place cliffs of basalt rose precipitously from the shore line. On the terrace

FIG. 7—Hold with Hope where the expedition first reached the coast of Greenland. July 17, 1931.

where we landed a great number of flowers were in full bloom. Patches of snow lay on the slopes above the western side of the terrace. Late in the afternoon we left for Mackenzie Bay. There were icebergs in the offing and a good deal of bay ice, but we experienced no difficulty in getting through.

THE ZONE IN DISPUTE BETWEEN NORWAY AND DENMARK

Mackenzie Bay is also known as Myggbukta, Mosquito Bay—and it is well named. The men of the wireless station had a bonfire on shore to guide us; the *Veslekari* anchored close in, and near midnight we landed. The station stands on a coastal flat a few feet above sea level (Fig. 8). Beside the two wireless masts is a good-sized wood cabin with storm entrance serving as a vestibule. Outside is a flagpole of some significance. From it flew the flag of Norway. Here, nineteen days earlier, the four men of the station, Hallvard Devold and his assistants, members of the Arktisk Naeringsdrift of Oslo, had raised the flag of their country and claimed part of East Greenland in the name of Norway, an action that was ratified by the Norwegian government a few days later. Here is a disputed zone, a source of rivalry between Norway and Denmark. Fortunately for science, the rivalry has led to intensive scientific work. Successive parties under the command of Dr. Lauge Koch have been at work since 1926, and this year (1932) Dr. Koch is taking out a still larger expedition. Through the initiative of Dr. Hoel a Norwegian expedition was sent out on the

FIG. 8—Myggbukta: hut, wireless station, and flagpole where four Norwegians raised the Norwegian flag on June 29, 1931, and took possession of the disputed territory of East Greenland between Carlsberg Fiord (lat. 71° 30′ N.) and latitude 75° 40′ N. and named it Eirik Raude Land. This act was later confirmed by the Norwegian Government.

Veslekari in 1929, and in the following years Dr. Hoel himself has headed expeditions to East Greenland.

At Mackenzie Bay we soon learned that the ice came in with the tide, and during the time it remained at the inner end of the bay we always had difficulty in maneuvering our launch. The floes packed themselves solidly together and forced us to land in different places along the shore in the vicinity of the wireless station. At no time, however, was the ice in the bay so heavy, nor did the bay have bergs of such size, as to oblige us to change the anchorage of the *Veslekari*.

Entrance to Franz Josef Fiord

Southward along the coast from Mackenzie Bay there were short stretches of ice through which we passed easily. A few large bergs lay outside the entrance to Franz Josef Fiord, at Cape Franklin where we landed July 20. Close by on the north shore was the cabin named "Smedalshutte" of the Arktisk Naeringsdrift. Mr. Richter, the occupant, was away. The hut was built of boards covered with tar paper. Standing against it was an old Eskimo kayak paddle of driftwood. On the shore were remains of five Eskimo huts. Flowers were in full bloom and with the vermilion and yellow cliffs made a brilliant picture. One large iceberg was seen to the southeast, and three huge ones 200 feet high to the west.

From Cape Franklin we followed close along the north shore of Franz Josef Fiord to North Fiord and thence to Hoelsbu in Musk-ox Fiord, another station of the Arktisk Naeringsdrift. Here we remained several days. Outside the hut of our hosts, Messrs. Grover and Johnson, was "Gunilla," a tame young musk ox who followed its masters with dog-like devotion wherever they went but scorned my offer of a tender willow branch. Several dozen white hares were in a wire enclosure near by. I was reminded of the blue and white foxes that the men were raising at Myggbukta and that were kept in enclosures. Messrs. Grover and Johnson accompanied us through the fiord, and I was able to photograph many musk oxen and to learn interesting details regarding the animal life and the flora of the region.

The extreme inner end of Musk-ox Fiord ends in wide mud flats. A broad pond-strewn lowland, five miles in length, separates it from the head of Loch Fyne. We climbed the ridge on the north shore of the fiord above the point where the *Veslekari* was anchored, whence we looked over the lowland. On the south side of the fiord are high peaks with snow upon them, and at the foot runs a rocky shore traversed by numerous small streams and ablaze with the purple-red of the largest mass of fireweed (*Epilobium*) that we saw anywhere. Characteristically sited on the north shore of the fiord were numerous remains of old Eskimo dwellings.

FIG. 9

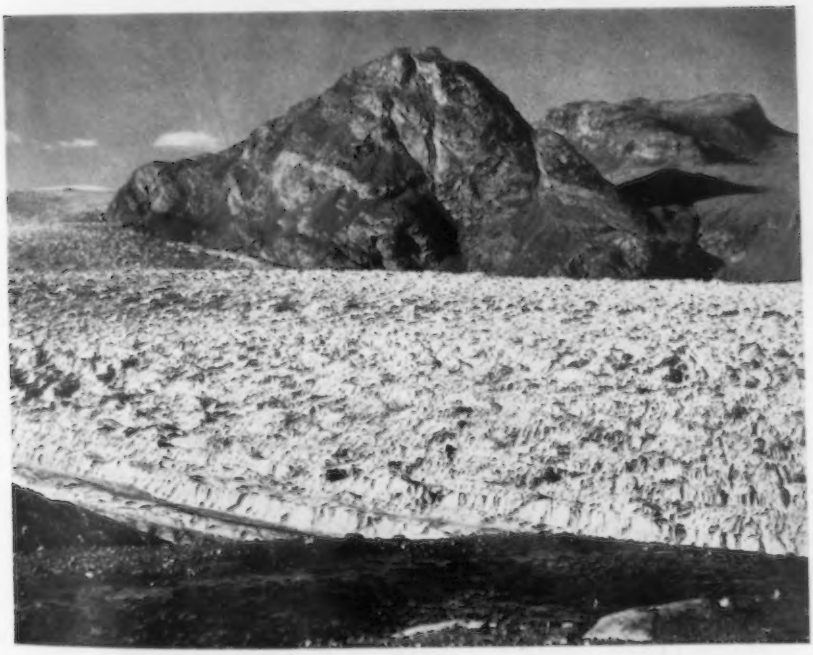

FIG. 10

FIG. 9—Looking southwest on the western side of Geologist Fiord, in which "folds, faults, and beautifully colored beds" of pre-Cambrian age are displayed in a remarkable manner (cf. Lauge Koch: The Geology of East Greenland, *Meddelelser om Grønland*, Vol. 73, 1929, pp. 1–204). July 25, 1931.

FIG. 10—Nunatak Glacier, at the head of Geologist Fiord, looking north-northeast. July 25, 1931.

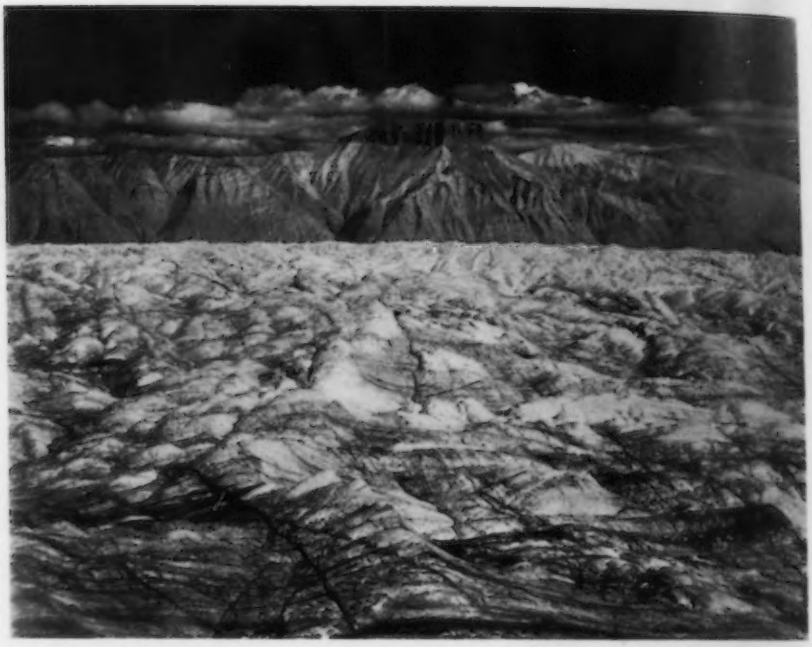

FIG. 11

FIG. 12

FIG. 11—Waltershausen Glacier, at the head of North Fiord, looking east across the full width of the glacier. In the center Torbern Bergman Mountain at the entrance of Musk-ox Fiord. July 24, 1931.

FIG. 12—The Teufelsschloss, 6000 feet elevation. Horizontal strata of pre-Devonian age are thrust over highly disturbed beds of the same age (cf. M. M. L. Parkinson and W. F. Whittard: The Geological Work of the Cambridge Expedition to East Greenland in 1929, *Quart. Journ. Geol. Soc. of London*, Vol. 87, 1931, pp. 651–674). July 26, 1931.

FIG. 13

FIG. 14

FIG. 13—Folded strata (pre-Devonian) on the western side of Ymer Island near Antarctic Sound. August 5, 1931.

FIG. 14—Shores of the large lake (Noa Lake) in the western part of Ymer Island in the depression leading from the head of Dûsen Fiord to Franz Josef Fiord. Musk ox appearing on the slope in the foreground. This part of Ymer Island supports an abundant plant and animal life. July 26, 1931.

On leaving Musk-ox Fiord we proceeded to Waltershausen Glacier at the head of North Fiord (Fig. 11). This huge river of ice is nine miles wide at its front. We landed on the southwest side and climbed about 1000 feet above the shore. The following day we went on to Geologist Fiord, lying between Strindberg Peninsula on the east and Andrée Land on the west, named by Nathorst for the two lost balloonists, pioneers of the air route in the north polar quest, whose funeral in Stockholm I had attended less than a year before.

Geologist Fiord to Ice Fiord

Geologist Fiord is very narrow. A glacier from Agardh Mountain on the west side comes right down to sea level. There was little snow to be seen, and vegetation was scarce. In the fiord were many small icebergs and much brash ice, but we succeeded in reaching its head, which is filled entirely by the large Nunatak Glacier, steep, pinnacled, and crevassed (Fig. 10). High above the west side we saw ptarmigan and near the front of the glacier spoor of bear, foxes, and hares. On leaving the fiord and rounding Cape Weber we reached Eleonore Bay and came upon a fine herd of musk oxen. Between this bay and the Teufelsschloss is most remarkable scenery, with the Teufelsschloss itself (Fig. 12) the most colorful feature of all this "colored country." One recalls Lieutenant Payer's enthusiastic description: "We had entered a basin, the shores of which were formed by rocks, which for glorious form and colour I had never seen equalled. . . . A colossal cubic rock on the small basis of a tongue of land stretched itself far into the Fjord, rising out of the blue water to a height of at least 5600 feet; regular reddish-yellow, black, and light stripes, showing the different layers of the stone. The terraces and towers on its edges resembled a ruined castle; we therefore called it the Devil's Castle."[3]

We anchored in Blomsterbukta, Bay of Flowers, the only bay on the west side of Ymer Island. Inland a lake-strewn valley (Fig. 14) leads to the head of Dusén Fiord, the great cut almost severing Ymer Island in two, as Lauge Koch has shown on his recent map.[4] While the island as a whole is reported poor in vegetation, the soil of the valley is rich and has a cover of low vegetation. Quantities of flowers were in full bloom, and we saw ptarmigan and many musk oxen hereabouts. From the island we had superb views of the high-colored banded rocks of the fiord walls, the scattered ice of the water surface, the distant fringes of white where the plateau edge appeared at the top of the fiord walls, and the bloom of flowers at our feet.

[3] Captain [Karl] Koldewey: The German Arctic Expedition of 1869–70, and Narrative of the Wreck of the "Hansa" in the Ice, London, 1874, reference on p. 552.

[4] Lauge Koch: Remarks on the Map of Dusén Fiord: *Meddelelser om Grønland*, Vol. 74, 1930, pp. 383–394.

FIG. 15

FIG. 16

FIG. 15—Looking southeast over Suess Land from Renbukten, Ice Fiord. At this time ice blocked further passage up the fiord. July 29, 1931.
FIG. 16—The *Veslekari* in Renbukten, Ice Fiord. July 29, 1931.

FIG. 17—Looking up the head of Franz Josef Fiord from our closest approach to Nordenskiöld Glacier. Compare Figure 18. July 31, 1931.

Between Andrée Land and Fraenkel Peninsula, named for the third member of Andrée's expedition, is Ice Fiord. Here we arrived on July 28, anchoring in Renbukten, near the mouth of the fiord, in 7 fathoms of water and 300 or 400 feet from shore. Renbukten is a small bay with two valleys opening into it from the inner end; one from the north, the other from the northeast. Snow lay in a large patch close to the water's edge. The western shore supported the usual vegetation; the eastern shore appeared steep and rocky. Here we saw many musk oxen as well as white hares. The day following we endeavored to reach the head of Ice Fiord. The fiord is narrow and giant icebergs so completely blocked our passage we were only able to go a few miles beyond our anchorage (Figs. 15 and 16).

HEAD OF FRANZ JOSEF FIORD

We therefore continued up Franz Josef Fiord. We reached the head of this great fiord on July 30, and I thus realized an ambition of three years' standing. We had come along the fiord over a course 180

FIG. 18—The head of Franz Josef Fiord from the position of Figure 17, looking outward. The reflections add to the great height of the fiord walls.

miles long from the outer coast. Ice-capped summits towered from three to seven thousand feet above the water, the walls of brilliant hue, the architecture of complicated and pleasing design. Glaciers of many types descended from the ice cap, some reaching the fiord water, some poised precariously on the fiord sides, others flowing out of narrow slits to end in great ridge-like moraines. No difficulty had been experienced in navigating Franz Josef Fiord, and we were able to anchor quite close to Nordenskiöld Glacier, which completely fills its inner end (Figs. 1, 2, 17, 18). In this we were more fortunate than Wordie's expedition of 1926 which could approach no closer than four miles from the glacier. The day was one of brilliant sunshine, with a temperature of over 80° F. Though surrounded by icebergs, glaciers, and the distant fringe of the ice cap, and though the water was bitterly cold, we had a most enjoyable dip in the fiord. Here was grass a foot and a half in height, the tallest found anywhere along the coast, and an abundance of flowers: gulls and ravens flew overhead.

FIG. 19

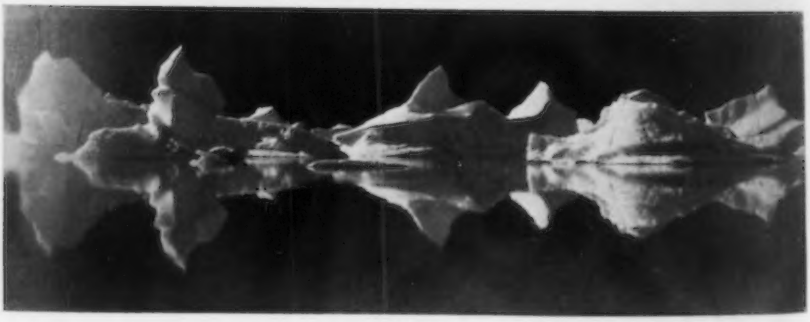

FIG. 20

FIG. 19—The head of Kjerulf Fiord. Looking from the valley floor to the line of stranded bergs and to the eastern wall of the fiord, on which the ice cap is conspicuous. August 1, 1931.

FIG. 20—Part of the row of fifty-five stranded bergs at the head of Kjerulf Fiord. August 1, 1931.

FIG. 21

FIG. 22

FIG. 21—The head of Ice Fiord showing the glacier "G" to the north of the "dividing spur." August 4, 1931.

FIG. 22—The head of Ice Fiord. Looking north-northeast over "G" Glacier. August 4, 1931.

Kjerulf Fiord

On July 31 we entered Kjerulf Fiord, whose general direction is north and south. Riddarborgen, 1800 meters, is the northwestern point. Off it, fairly close to shore, we saw our first narwhals, three of them, their long ivory horns appearing above the surface of the water like crossed sabers. We maneuvered to get one, but all our attempts failed. At this same point on the following day members of my party caught our only fish, two or three salmon and a small fish with a large, grotesque head—more head than body. On the south side of Franz Josef Fiord at the entrance to Kjerulf Fiord were several large icebergs, too many to permit us to take the *Veslekari* to the inner end, and we had to use the launch for this purpose. The *Veslekari* was anchored under Riddarborgen near the place used by Wordie as a starting point for his ascent of Petermann Peak. We went ashore and climbed a few hundred feet up the valley immediately south. Here were growing the largest willows, 18 inches high, that we saw anywhere in Greenland. One extraordinary specimen found here is described in the appendix. Above us, on the south side of the stream, were three glaciers, of great thickness of ice.

On the bank close to shore was a cairn: we found nothing by which to learn its origin or reason for being there. Farther in the fiord, also on the west side, is a glacier that does not now reach the sea; but its moraine extends to the shore, and from it a delta is built far out. There were no glaciers of importance on the east side of the fiord. The ice cap appeared clearly visible on the summits of both walls (Fig. 19).

Connection between Kjerulf and Dickson Fiords

Kjerulf Fiord was to lead to the most interesting and important discovery of the expedition, the results of which are shown on the map, Plate III. Unlike the majority of the fiords, Kjerulf has no glacier at its head but terminates in mud flats. We landed on the western side at the right of a line of grounded bergs that stretched almost the entire width of the fiord and, skirting the mud flats, reached the gravelly boulder-strewn floor of a broad valley. Facing us was a sharp peak, its sides corrugated with erosion channels (Fig. 3). I named it "J.F.B." Mountain.[5] It stands at the junction of two valleys, a right valley leading towards the south and a left valley descending from the west (Fig. 4). Streams flow down both valleys and uniting form the braided stream occupying the main valley with principal channel on the eastern side. From the junction looking up

[5] J. F. B. stands for John F. Boyd. I wish to have the mountain so named in memory of my father, a pioneer in the mining industry of the west of the United States of America, through whom my Arctic voyages have been made possible. Elsewhere in this article newly discovered features are identified by initials pending the decision on names.

FIG. 23

FIG. 24

FIG. 23—The head of Ice Fiord. In the center, the "dividing spur"; on the left, the valley down which Jätte Glacier descends. August 4, 1931.

FIG. 24—The head of Kjerulf Fiord. Looking up the entire length of the right valley and over Hisinger Glacier to "C" Mountain. The small lake and stream issuing from it are visible. The left valley stream is in the foreground. Compare Figures 3 and 4. August 1, 1931.

FIG. 25

FIG. 26

FIG. 25—View from the "divide" between Kjerulf Fiord and Dickson Fiord. In the background the eastern wall of the "unknown valley" down which Hisinger Glacier flows. "C" Mountain at the extreme left. In the right center, streams from the glacier flowing into the lake whence issues the right valley stream. August 2, 1931.

FIG. 26—Hisinger Glacier seen from the "divide" between Kjerulf and Dickson fiords, looking south-southwest. The largest of the streams seen issuing from the glacier is in the foreground; in the background, a snow-covered peak rising apparently from the center of the glacier. August 2, 1931.

FIG. 27

FIG. 28

FIG. 27—Looking over the terminus of Hisinger Glacier into Dickson Fiord from the northern side. This was the farthest point reached overland from Kjerulf Fiord. Note the distinctive landmark in the ice cap of the mountains in the background and compare Figure 29. August 2, 1931.

FIG. 28—The head of Dickson Fiord from the southern side looking east-northeast. The front of Hisinger Glacier in the foreground; in the left background the north wall of the fiord; in the right background the south wall, which here swings sharply to north-northeast. The *Veslekari* is seen in the center of the view. August 6, 1931.

the right valley I could see a range of snow-domed peaks. I also saw to the southeast another striking mountain, capped by snow or ice in the form of a double scoop. This landmark is identified as "C." From a higher point a valley filled by a large glacier could be seen at the foot of "C." I determined to find where the glacier ended, but it was too late to do more that day.

The next morning, August 2, we landed on the eastern side of the fiord as far in as the mud flats permitted and to the east of the main channel of the stream and proceeded towards the unknown valley. The day was warm and sunny and the visibility excellent. "C" appeared to be the northern terminus of a southward-trending ridge from which descended many glaciers. From what seemed to be a divide I saw in the distance a snow-covered peak rising apparently from the center of the glacier, but it was impossible to tell if it were indeed a nunatak (Fig. 26). A great lobe from the glacier closed the valley on the west. From it issued a fair-sized stream that entered a small lake, whose outlet was the stream flowing down the right valley to Kjerulf Fiord (Figs. 24 and 25). I continued along the base of the mountains, which here trended more east than south, for a long distance before my search was rewarded. At last, at 4.50 p. m., after six hours' walking with stops only for photography, I and four of the crew reached a point from which we saw below us the great glacier end in a fiord. The mountains curved to the northeast forming the western wall of the fiord below us.

What was it? Could it be Dickson Fiord and the glacier the Hisinger? No map showed such a connection nor hinted at the possibility that waters from this glacier found an outlet in Kjerulf Fiord. Below us could be seen the entire width of the glacier. Many small icebergs were scattered about, a point of land lay on the left or north side, and ice-capped mountains formed the south side of the fiord and curved sharply in the distance northward closing to view the outer end of the fiord. Above me, on the north, the ice cap had a distinctive shape, which might readily be used for identification purposes (Fig. 27). I shall here anticipate the narrative by saying that four days later, on August 6, we reached the inner end of Dickson Fiord, and my detailed notes and pencil drawings of specific points agreed with what we now saw.

After a short rest we started back over the route by which we had come, keeping as close as possible to the margin of the glacier and, reaching the lake and stream of the right valley, returned along the edge of the stream.

That night as we were returning to the *Veslekari* we counted between 525 and 530 icebergs, omitting those of small size. Of these, 55 were stranded at the head close together (Fig. 20). Forty-two of them had almost completely blocked the fiord at one point, leaving

open water of a width barely sufficient to get the launch through. Other groups numbered 69, 143, 42, 16, some of the groups averaging not less than 100 feet in height above the water.

FIG. 29—The head of Ice Fiord. Jätte Glacier and matterhorn, "S" Peak. August 4, 1931.

On August 3 I spent a good part of the day photographing both sides of Kjerulf Fiord throughout its length. There were so many large icebergs massed along the eastern side of the fiord that this was the only time we went the entire length of that side.

SECOND VISIT TO ICE FIORD

The weather seeming favorable, I decided to return to Ice Fiord and make another attempt to reach its head. Its walls rise to lesser heights than do the walls of other fiords we had visited. There was

little snow on either side of the fiord, no glaciers worthy of special mention, no waterfall. Shortly before noon we attained our objective. Throughout its length the fiord is narrow, but at the head it widens out into a bay and in this respect is totally unlike any of the other fiords. As we faced inward the Jätte Glacier was to the west, then came a dividing spur over which one saw the ice cap, and from it a small glacier descending part way down the spur, then an entirely separate glacier of great width coming from the north and northwest side of the dividing spur (Fig. 23). Jätte Glacier does not alone fill the inner end of the fiord, as is shown on the Nathorst expedition's map. We landed at several places on the dividing spur and got as close as possible to the glacier, "G" (Figs. 21 and 22). The "G" glacier was calving numerous bergs and its face was rough and crevassed. Its course from the northwest is through a very gently sloping valley which it completely fills. To the north and northwest are tributary valleys with smaller glaciers, and the inland ice was clearly visible. Jätte Glacier, which is smaller than the "G" glacier, is dominated on the southwest by a matterhorn, "S" (Fig. 29), on whose east face are glaciers. From our observations Ice Fiord heads much farther inland than is shown on previous maps (Fig. 30). The possibilities of glacial retreat should not be overlooked. Large oscillations have been recorded for some Greenland glaciers, notably Jakobshavn Glacier on the west coast.

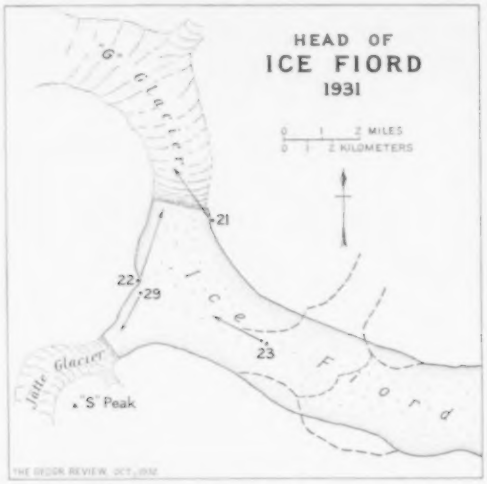

FIG. 30—Head of Ice Fiord as observed by the author, August 4, 1931. The dotted line shows the delineation on Dusén's map, 1899 (Swedish Expedition to Northeast Greenland under Nathorst). The numbers refer to photographs in the text, the arrows giving orientation. Compare the inset map on Plate III. Scale of map 1 : 316,800.

By late afternoon icebergs so completely encompassed the *Veslekari* that we had to give up further exploration in Ice Fiord. When we passed out of the fiord we had completed an examination of every arm and branch of the entire Franz Josef Fiord area, had landed at the extreme end of every fiord, and had taken numerous photographs from every station that we occupied. We now started for the King Oscar Fiord area, stopping at the entrance to Antarctic Sound and noting the remains of old Eskimo dwellings on the Suess Land shore where the soil is thick and the vegetation abundant.

Antarctic Sound to Kempe Fiord

Passing into Antarctic Sound, August 5, we encountered no sea ice, only small bergs. The weather remained warm, with brilliant sunshine. We kept close to the eastern shore of Suess Land, between it and Ruth and Maria islands. The ice cap and mountains of the land were at all times clearly visible. At Cape Elizabeth, the northeastern corner of Ella Island, in accordance with plans made by wireless, I met my good friend Dr. Hoel of the Norwegian expedition on board the *Polarbjørn*. Our two ships were made fast, and we spent a couple of hours together. His entomologist was so interested in a ladybug we had found that we gave it to him: he said no specimen had been found in East Greenland before. Dr. Hoel reported the find on August 3 on Bonteko Island at a point about 300 meters above sea level of a cairn about a meter high, in which was a bottle containing a paper luggage tag that carried this inscription:

1899, Svenska-Polar Expedition

The Swedish Expedition on Antarctic in search of Andree and his companions left Stockholm May 20th, 1899 and visited this point July 22nd. The Expedition intends to examine the coast southwards until Scoresby Sund. A. G. Nathorst. A depot is for Sverdrup on Walrus Island near Sabine Island.

Dickson Fiord and Other Arms of Kempe Fiord

Continuing west through Kempe Fiord we entered Dickson Fiord, its northernmost arm, on August 6. One glacier on the north wall had gouged out a deep gorge from the summit to the water's edge. At the head of the fiord is Hisinger Glacier. We reached the glacier, and I was able to recognize landmarks seen on August 2, during my reconnaissance from the head of Kjerulf Fiord (Fig. 28). We landed on the south side and followed up the glacier some distance to a point whence I could look down the right valley. A stream flows on the south side of Hisinger Glacier into the head of the fiord. Here and there the ubiquitous fireweed was in bloom.

Hisinger Glacier is impressive in its grandeur—excessively crevassed and of great length and width. It will not surprise me if it exceeds Nordenskiöld Glacier in size, being second largest of the glaciers in this area, exceeded only by Waltershausen.

The center arm of Kempe Fiord is Röhss Fiord, where we anchored at the narrows, the water so deep that we had but few feet between ship and shore. The high hillsides above us were covered with ripe blueberries. By launch we reached the shallow waters and mud flats of the extreme inner end. This fiord, unlike most of the others, had no glacier at its head.

The south arm of Kempe Fiord, Rhedin Fiord, into which we next passed, runs northeast to southwest. Wahlenberg Glacier at its inner end is wide but very thin and completely fills a valley whose trend is southwest. Close by to the east are two glaciers separated by a low moraine. There are tributary valleys with glaciers on both sides of the fiord, especially the eastern side, Lyell Land.

FIG. 31—The north side of Snohattan, Lyell Land, at the junction of Rhedin and Kempe fiords. August 7, 1931.

Commanding the northeastern entrance of Rhedin Fiord is the fine peak of Snohättan. The north side had the hard appearance of glacier ice rather than snow cap, and from a valley a glacier descended with large lateral moraines (Fig. 31). Narwhals were very numerous at the entrance of Rhedin Fiord and close in shore. But we never got even near enough to use the harpoon gun.

DUSÉN FIORD TO ANTARCTIC HARBOR

On August 8 we anchored in Dusén Fiord, where we remained for two days while the boilers of the ship were being cleaned. We went to the inner end by launch. On the north side of the fiord, not far from the head, was the largest herd of musk oxen we saw at any one time. Up to date we had seen 274 of these creatures; we photographed many but did no hunting. From the head of the fiord I went on foot westward to a point from which I looked across the island to Blomsterbukta in Franz Josef Fiord, where we had been on July 26. I had now reached the easternmost of the lakes visited from the other end of Ymer Island. Besides the musk oxen we saw a ptarmigan hen with her young and one lone baby skua whose excited mother overhead flew so low she almost touched our heads.

On August 10 we stopped at Cape Humboldt on Sofia Sound to pay our respects to Commander von Krogh of the Royal Norwegian Navy, who was doing hydrographic work. The hut there belongs to the Arktisk Naeringsdrift and is similar to those we had seen elsewhere. Commander von Krogh unfortunately was absent, but we later met him in Norway.

Fig. 32—The head of Alp Fiord with Sefström Glacier. Note the "dirty" condition of the surface of the glacier. August 12, 1931.

Returning through Sofia Sound we encountered our first fog. The mountains on both sides seemed particularly bare and desolate. Most of the glaciers were covered with dirt: the large size of the glacial moraines throughout the sounds and branches of King Oscar Fiord was indeed noticeable. We entered Vega Sound between Geographical Society Island on the north and Traill Island on the south; but fog prevented us from reaching the Scott Keltie Islands, beyond which we knew we could not take the ship because of shallow water.

Retracing our way we continued southward through King Oscar Fiord. The contrast between the fiord and its northern neighbor, Franz Josef Fiord, is great. The narrowness and the high walls of the latter give an intimate feeling, whereas the great width and expansive view of the former produce an entirely different impression.

South of Lyell Land is the wide Segelsällskapet Fiord. We landed on its southern side, Scoresby Land, at the foot of the Murchison Mountains opposite Berzelius Peak, whose brilliantly colored strata rival those of the Teufelsschloss. The western arm of Segelsällskapet is known as Forsblad Fiord. Its high walls are broken by many glaciers. Alp Fiord is the other arm of Segelsällskapet, and Sefström Glacier fills the inner end (Fig. 32); numerous glaciers also descend its walls.

FIG. 33

FIG. 34

FIG. 33—A typical hanging glacier in Dickson Fiord. August 6, 1931.
FIG. 34—Glacier on the south side of Kempe Fiord just east of Snohattan. August 7, 1931.

We halted at Cape Petersens, at the southern entrance to Segelsällskapet Fiord, but the small wooden hut on the shore was boarded up; so we proceeded to Antarctic Harbor in Davy's Sound, where we went ashore and visited "Bakkehuset" of the More Gronlands Ekspedisson of Aalesund, erected in 1930. The two Norwegians stated that musk oxen were numerous in the vicinity. The men had fourteen dogs, and close to the hut was a strong, healthy clump of rhubarb growing in a wire enclosure.

Leaving Antarctic Harbor we passed southward and in so doing completed our visit to King Oscar and Franz Josef fiords.

ICEBERGS AND ICE SOUNDS

Between Franz Josef and King Oscar fiords we found a very striking contrast in respect to ice. Throughout the entire King Oscar Fiord area, including all of its many off-branching fiords and sounds, sea ice was absent, and we encountered no icebergs worthy of record. Throughout Franz Josef Fiord and some of its branches were large icebergs, many of them grounded. The icebergs provide one of the chief sources of noise in what Mr. Stefansson calls the misnamed "silent" North. When a berg calves from the front of a glacier there is produced a blasting sound. A minor note is the trickle of small water-

FIG. 35

FIG. 36

FIG. 35—Glacier on the south side of Forsblad Fiord near the narrows. August 12, 1931.
FIG. 36—"The Great Claw," a hanging glacier on the eastern wall of Alp Fiord near the head of the fiord. August 12, 1931.

ways that stream off the larger bergs or the drip-drip of water that splashes from the sides. In the smaller ice one notices a crackling sound, and occasionally there is the swish against the shore of waves that come from some giant berg that has turned over or broken up—an event that comes sometimes without warning to these great masses of ice that seem but a moment before to be marble-like and everlasting. Loudest of all is the sound of cannonading, the booming sound of bursting ice as a large berg breaks up. Reflected from the high walls and narrow passageways of the fiords, the sound reverberates in exaggerated tones and is the dominating note of the region.

VISIT TO SCORESBY SOUND

Off the Liverpool coast there was no ice worthy of mention, and going south we were able to keep our course reasonably close to shore. On August 14 we arrived at Scoresby Sound. On the northern shore not far from the entrance is the Danish settlement.[6] Mr. Henrik Hoegh, the administrator, came out in his launch to greet us, and several Eskimos in their kayaks paddled about. We all went ashore,

[6] On the foundation of the settlement see Ejnar Mikkelsen: The Colonization of Eastern Greenland: Eskimo Settlement on Scoresby Sound, *Geogr. Rev.*, Vol. 17, 1927, pp. 207–225.

landing at a small wooden dock. To this was moored the seaplane *Grønland Wal* in which Captain von Gronau and three companions were en route from Germany to America by Iceland and Greenland. We also met Mr. Kerdahl, who has charge of the seismographic and wireless station.

The settlement lies on the south slope of a hill and comprises the residence of the administrator of the colony and his family; a church with the house in which live Pastor Abelsen and his family; a store

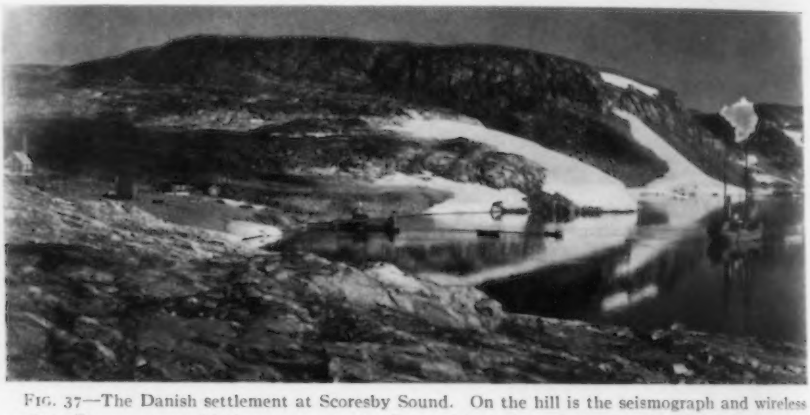

FIG. 37—The Danish settlement at Scoresby Sound. On the hill is the seismograph and wireless station. The cemetery with three crosses can be distinguished. At anchor are the *Veslekari* and Captain von Gronau's seaplane *Grønland Wal*. August 14, 1931.

and work sheds; the residence of Mr. and Mrs. Kerdahl, where guests coming to the colony are invited to stay; the house of Mr. Hanson, in charge of construction, and his wife; and the houses in which the small colony of Eskimos live. Here we spent a couple of delightful days.

We went farther in the Sound to the Eskimo settlements at Cape Hope and Cape Stewart. Here, at the entrance to Hurry Inlet were the largest icebergs that we saw on the entire trip. While we were at Cape Hope, Captain von Gronau and his companions passed over our heads in their *Grønland Wal*. The Eskimos ran to the flagpole and dipped the Danish flag in salute. The Eskimos—men, women, and children—returned with us on the *Veslekari* to the larger settlement, taking advantage of this opportunity to attend church the following morning.

On Sunday, August 16, eleven members of the *Veslekari* and twenty-seven Eskimos attended divine service in the Lutheran church at Scoresby Sound. The service was entirely in Greenlandic (the Eskimos prefer to be known as Greenlanders) except a short talk in Danish for the strangers (our party) visiting the colony and a prayer in Danish for their safe journey home. After the service we went to the manse where we had "church coffee" with Mr. and Mrs. Abelsen

and their charming daughters. Later in the day we took the Eskimos a splendid, kindly people, back to their homes at Cape Hope and Cape Stewart. We sent the women and children ashore in the launch, and the kayaks raced each other to land. As we left I saw seven flashes, in a row, and heard as many rifle shots. We blew the *Veslekari's* whistle in acknowledgment of the salute. Seven more flashes and shots as they lined up on the shore bade us farewell. With that touching incident we left Greenland for home.

We followed the coast line northward and encountered little ice. Reaching Little Pendulum Islands and Bass Rock on August 19, we bade goodbye to Greenland and set our course for Norway. No large floes were encountered, and in two days we were entirely out of the ice.

APPENDIX I—BOTANICAL COLLECTIONS OF THE LOUISE A. BOYD EXPEDITION

R. H. Menzies

Ostenfeld, in his "Flora of Greenland and Its Origin" (1926) records a total of eighty-nine species of flowering plants occurring on the coast of East Greenland between latitudes 71° and 76° N., which includes the area visited by the Louise A. Boyd Expedition of 1931. Of these, all but four species are common to North America, and no endemic species are known to occur.

An examination of our plant material by the Herbarium of the Royal Botanic Gardens at Kew[1] and by Miss Alice Eastwood of the California Academy of Sciences, San Francisco, discloses the fact that the expedition had collected 77 of the 89 species and, in addition, three not recorded by Ostenfeld (*Torularia humilis*, *Erigeron unalaschkensis*, *Pinguicula vulgaris*).[2]

On July 9, en route to Greenland, the expedition touched at Jan Mayen Island. Unfortunately the writer who was chiefly concerned with plant collecting was incapacitated and unable to take part in either of the two expeditions on land. Miss Boyd, however, returned to the ship with a collection of 22 species including what later proved to be a new species of *Taraxacum* and the only new species discovered by the expedition.

On Cape Hold-With-Hope, July 17, several species of *Cerastium*, *Potentilla*, and the ubiquitous Iceland poppy were in flower on the gravelly beach beyond which there was a soil flow, a phenomenon characteristic of polar lands and of great importance in relation to their vegetation.[3] The mass of slowly moving soil, saturated with moisture from the recently melted snow, resembled a flow of lava three or four feet high, where it met the beach. It extended a thousand yards back from the beach at an angle of thirty degrees, terminating in a talus below high rocky cliffs. On it grew a thick matted growth of *Vaccinium* already in fruit, with few flowers remaining,

[1] Specimens of *Taraxacum*, *Erigeron*, *Lychnis*, *Draba*, and *Braya* were identified by Dr. Johannes Lid of Oslo, and specimens of *Salix* by Dr. B. G. O. Floderus of Stockholm. A set of the plant material is deposited at Kew, and another set with the California Academy of Sciences. A list of the plants is on file at the American Geographical Society.

[2] *Erigeron unalaschkensis* was reported by Lauge Koch's expedition in 1929 (see Gunnar Seidenfaden: Moving Soil and Vegetation in East Greenland, *Meddelelser om Grønland*, Vol. 87, 1931, No. 2) and by the Norwegian expeditions in 1929 and 1930 (see Jakob Vaage: Vascular Plants from Eirik Raude's Land, *Skrifter om Svalbard og Ishavet*, No. 48, 1932).

[3] Seidenfaden, *op. cit.*

together with the creeping Arctic willow, *Arctostaphylos*, *Dryas*, and *Cassiope*, the two latter in full bloom. These same plants, and generally in like association, were met with throughout the entire journey within the fiord area and comprised the highest (about 12 or 18 inches) and only woody growth, though farther inland there mingled with them the dwarf birch, *Rhododendron lapponicum*, and *Empetrum*, the whole producing a heath-like appearance in which the flowers of *Dryas* and *Cassiope* were conspicuous. On dryer ground to the side of the soil flow we first saw *Epilobium latifolium*, a brilliant and large flowered willow-herb, generally from six to twelve inches tall. With *Dryas* and *Cassiope* it proved to be the commonest and most generally distributed, as well as the most striking, of the flora.

At the head of Musk-ox Fiord *Epilobium* covered many acres of sandy delta and presented a sheet of color comparable to a field of *Eschscholtzia* in California. In contrast to this display a single plant formed a spot of color some 150 feet up on the otherwise bare glacial polished face of a granite wall alongside Nunatak Glacier in Geologist Fiord.

On arriving at Musk-ox Fiord July 22, we found the short flowering season at its height. Here on a walk from the beach to a height of 1800 feet, where growth ceased because of the lack of earth, some seventy per cent of the species shown on our list were met with in flower. Dense patches, half an acre in extent in many cases, presented an unbroken surface of bloom, the background consisting of the yellow daisy-like flowers of *Dryas* and the white bells of *Cassiope* through which *Pyrola grandiflora* thrust its delicate pink. In smaller number but of more brilliant hue were *Epilobium*, *Rhododendron lapponicum*, *Silene acaulis*, *Saxifraga oppositifolia*, *Pedicularis*, *Campanula rotundifolia*, *C. uniflora*, *Arnica*, and *Lesquerella*.

A week later at Renbukten, July 29, nearly all of the plants had begun to seed, though at the time the writer made note from where he sat on the open heath of the following species still in bloom and all within a radius of six feet; *Silene acaulis*, *Dryas*, *Cassiope*, *Vaccinium*, *Salix*, *Arnica*, *Melandrium*, *Polygonum*, *Draba*, *Pedicularis*, and, within view, *Papaver*, *Epilobium*, and *Pyrola*, an indication of the variety in so limited a space. The day following, at a point not far from the junction of Ice and Franz Josef fiords, we found upon a boggy tableland some sixty feet above the beach the most luxurious flora yet met with and here, in moist ground, discovered for the first time, two small colonies of *Pinguicula* (*Pinguicula vulgaris*) a genus not before reported on the east coast, nor did we again find it at any other point.

The day following, at the head of Franz Josef Fiord and close to Nordenskiöld Glacier where precipitous cliffs gave little or no opportunity for plant growth, we encountered a steep-sloping shelf of rock rising directly from the fiord and bearing a fertile grassy spot about a quarter of an acre in extent with deep pockets of soil. The ledge was evidently the haunt of bears or wolves, and much animal excrement lay about. The effect of the fertilization was very noticeable, and we collected specimens of *Lesquerella* and *Cerastium* from twelve to sixteen inches high, whereas, under ordinary conditions neither plant had before been found to exceed six inches in height. Here, too, we found *Gentiana tenella* for the only time on our trip.

By August 1 almost no flowers remained, and the willows were discharging their seeds upon the lightest breeze. The long seed pods of *Epilobium* were beginning to turn purple and *Arctostaphylos* and *Vaccinium* berries were fully ripe and very abundant. So dry had the soil and vegetation become that a kick from one's foot would dislodge a clump of *Cassiope* with its accumulated underlying dead vegetable matter, the whole forming a peat-like sod readily ignited.

At the extreme end of Alp Fiord, a willow, *Salix arctica*, was found, which far exceeded in size any other met with. It grew in loose sand and gravel at the base of a boulder ten or twelve feet in diameter, its roots within easy reach of a small stream. Half the branches extended outward from the base of the boulder and formed a semicircle with a radius of five or six feet from the stem, the other half

MAP OF THE HEADS OF KJERULF AND DICKSON FIORDS EAST GREENLAND 1931

From a photographic reconnaissance by

LOUISE A. BOYD

Constructed at the American Geographical Society by Walter A. Wood and John D. Kay

Approximate scale 1:50,000 — Form line interval 50 meters

0 1 2 3 4 5 Kilometers
0 1 2 3 Miles

Position of control camera stations indicated by ⊙ — *Spot heights in parentheses indicate weak control*

RELATIVE RELIABILITY

1 *Strong control, detail adequately shown in photographs*
2 *Strong control, inadequate detail*
3 *Weak control, adequate detail*
4 *Weak control, inadequate detail*

MAP OF THE HEADS OF KJERULF AND DICKSON FIORDS EAST GREENLAND 1931

From a photographic reconnaissance by

LOUISE A. BOYD

Constructed at the American Geographical Society by Walter A. Wood and John D. Kay

Approximate scale 1:50,000 — Form line interval 50 meters

0 1 2 3 4 5 Kilometers
0 1 2 3 Miles

Position of control camera stations indicated by ⊙ — *Spot heights in parentheses indicate weak control*

1 Strong control, detail adequately shown in photographs
2 Strong control, inadequate detail
3 Weak control, adequate detail
4 Weak control, inadequate detail

THE ROUTE OF THE
LOUISE A. BOYD EXPEDITION
IN THE REGION OF FRANZ JOSEF AND
KING OSCAR FIORDS
1931

SCALE: 1:1900000 0 10 20 30 K. / 0 10 20 M.

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clambering closely over the boulder for a like distance but in a vertical direction, corresponding to the rock surface. The most remarkable feature of the plant was its freshness and vigor. Not so much as a dead or broken twig was visible, and in all probability its unusual size was more to be accounted for by favorable growing conditions than extreme age. Another favorable circumstance was the apparent absence of musk oxen, the spot being inaccessible for these animals, which subsist principally on the willow, especially during the winter.

By the time we reached Scoresby Sound, August 15, few if any flowers remained in bloom. *Ranunculus glacialis*, in bud and flower in rock clefts, was, however, a notable exception. This species had last been seen by us at Cape Franklin where it was in flower on July 20, nearly a month earlier and two hundred miles farther north, a circumstance that would indicate an unusually prolonged blooming period for the Arctic.

APPENDIX II—METHOD OF CONSTRUCTING THE MAP, PLATE III

No actual survey measurements were made on the ground, but on the other hand the photographic reconnaissance was complete: more than 200 photographs were taken from about 50 positions to cover the region shown on the map, which is about 80 square miles in extent. Under these circumstances, the exact scale and orientation of the map are unknown and have had to be assumed. However, it is considered unlikely that there is as much as a 5 per cent error in scale or that the orientation of the map is out more than a few degrees.

The first stage in the construction of the map consisted in fixing the relative positions of four camera stations and six conspicuous points appearing in each of four photographs (see *Geogr. Rev.*, Vol. 21, 1931, pp. 209–212). Once this was accomplished additional points were fixed by intersection, and additional camera stations by resection, until finally the whole area was covered by a network of 34 points and 12 camera stations whose relative horizontal positions were known.

The true horizon trace on most of the photographs was determined by working through consecutive photographs in a panoramic set and by deduction from the perspective. There was found to be little tilt, and the horizontal and vertical angles to all major control points were extracted by the rigorous formulae (see *Geogr. Rev.*, Vol. 21, 1931, pp. 660–661). Relative differences of height were determined in the usual way and gave a good check on the accuracy of the angles extracted. Where any large discrepancy between the height of a point as determined from two or three stations was found, it was presumed to be from an error in assuming tilt in one or the other of the photographs, and it was generally possible to decide in which one of these photographs the error had taken place.

The horizontal positions of the many minor control points were then fixed by the approximate graphical method, and their differences in height from vertical angles were computed by the rigorous formula.

With this control as a base, the topographic detail was sketched in with the aid of the photographs used in the control and of the many others taken in the region.

The assumption of scale was based on the width of the Hisinger Glacier where it ends at the head of Dickson Fiord, as shown in Wordie's map (Nordenskiöld Glacier and Petermann Peak, 1 : 250,000, *Geogr. Journ.*, Vol. 75, 1930, facing p. 568), and on the probability that the height of the snow fields bordering the fiords would be the same as those a little farther north already mapped. These two assumptions agreed well with each other. The assumption of orientation was based on the actual observation that the left valley ran approximately east and west, and it seems to fit in well with the relationship of the area to that mapped by Wordie.

The map was constructed at the American Geographical Society by Walter A. Wood and John D. Kay, and the topography was edited by Charles H. Hitchcock.

LOST VALLEYS OF PERU

RESULTS OF THE SHIPPEE-JOHNSON PERUVIAN EXPEDITION*

Robert Shippee

[With separate mosaic map, Pl. IV, facing p. 580]

ONE of the principal objectives of the Shippee-Johnson Peruvian Expedition of 1931 was to map from the air, and to study and photograph on the ground, the agricultural communities on the floor of the deep valley of the Colca River some seventy miles north of Arequipa. Lieutenant Johnson had already made a few photographs of them in 1929 while he was serving as Chief Photographer of the Peruvian Naval Air Service.[1] He had come upon them quite by accident during a photographic flight among the snow-capped, volcanic crests that surmount the plateau of the Andes north of Arequipa and, on his return to Arequipa and later in Lima, was unable to find anyone who had ever heard of them, although his photographs revealed a number of good-sized villages laid out in the rectangular pattern characteristic of Spanish-American towns as distinguished from settlements of purely Indian origin, extensive terraces and irrigation systems, long, winding trails leading up the steep ascents to the plateau, and stone corrals and shepherds' huts on the summit.

Further inquiries after Johnson returned to the United States revealed, however, that the villages of the Colca Valley were not so completely unknown as had appeared to be the case at first. Many maps of both the colonial period and the early years of the republic gave indications of them, and it was found that on the map of the department of Arequipa in the Paz Soldán atlas of 1865 and on the famous map of Peru compiled by Antonio Raimondi during the 1880's they were shown in approximately their correct location.

It seemed reasonable to believe, from the nearness of the valley to the mines at Cailloma, that the settlements there belonged to a type of agricultural community which the Spaniards established on the rich, well-watered alluvial fill of many of the deep, sheltered valleys of the Andes to supply food, clothing, and pack animals to near-by mining centers, frequently by a reorganization of already existing Indian communities.

* Compare Robert Shippee: The "Great Wall of Peru" and Other Aerial Photographic Studies by the Shippee-Johnson Peruvian Expedition, *Geogr. Rev.*, Vol. 22, 1932, pp. 1–29.

[1] George R. Johnson: Peru from the Air, *Amer. Geogr. Soc. Special Publ. No. 12*, 1930, Figures 23–28.

Today little is known of any of these communities, except by those directly dependent on them, even where the mining districts served by them are still flourishing.[2] If the mines served by a particular

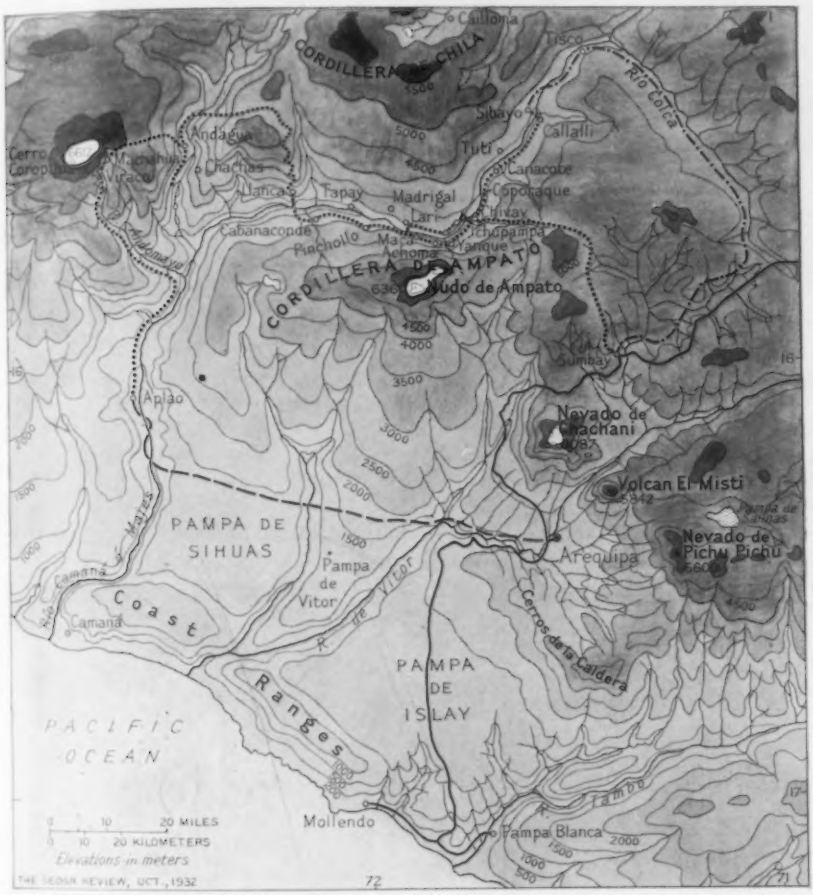

FIG. 1.—Map showing the route on the ground of the Shippee-Johnson expedition to the Colca and Andagua valleys. The route is thus: solid line, railway; dot-and-dash, motor truck; dotted line, mule-back; dashed line, automobile. Scale of map 1:1,900,000.

community cease operations or their output falls to a negligible figure, as has been the case at various times with the mines at Cailloma, the people of that community must either move to new land or, as is more often the case, settle down to a self-contained existence with the result that they are finally all but forgotten. Such, it appeared, had been the case with the agricultural communities of the Colca Valley.

In addition to his own very natural desire to know more of the seemingly mysterious villages that had suddenly and unexpectedly

[2] Compare O. M. Miller: The 1927–1928 Peruvian Expedition of the American Geographical Society, *Geogr. Rev.*, Vol. 19, 1929, pp. 1–37.

FIG. 2

FIG. 3

FIG. 2—View across the lower Colca Valley to the snow-capped Nudo de Ampato.
FIG. 3—A group of six volcanoes in the Andagua Valley. For location see the mosaic. Pl. IV.

FIG. 4

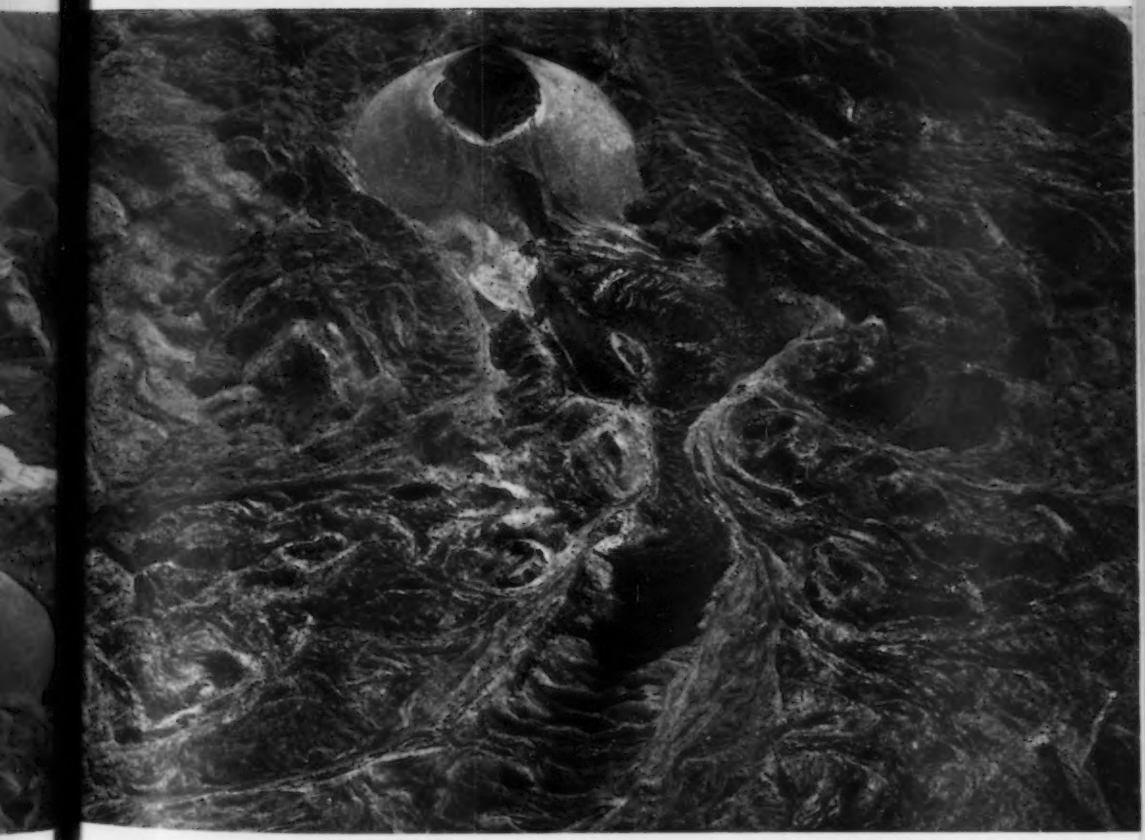

FIG. 5

FIG. 4—The gorge of the Colca River near the village of Pinchollo.
FIG. 5—An oblique view of the volcano climbed by the expedition, an almost perfect cone.

FIG. 2—View across the lower Colca Valley to the snow-capped Nudo de Ampato.
FIG. 3—A group of six volcanoes in the Andagua Valley. For location see the mosaic. Pl. IV.

appeared beneath his plane in the midst of the desolate puna, Johnson found the American Geographical Society greatly interested in his photographs and eager to know something of the history of the villages, their present mode of life, the crops they grew, their methods of cultivation, and where they marketed any possible surplus products. When our expedition was finally organized the Society furnished us with a detailed questionnaire for our guidance in studying the valley.

EXPLORATION OF THE COLCA AND ANDAGUA VALLEYS

We left the exploration of the Colca Valley until we had finished our work in northern and central Peru and in the Cuzco region, in order not only that we might undertake it under the best possible weather conditions but also that we might come to the work of mapping the valley with as thorough experience as possible with flying and photographic conditions in the high Andes.

It was, therefore, not until June 16, 1931, that we left Arequipa for our first trip into the valley by land. We had, however, on May 6 and 7, made reconnaissance flights over the valley to look for possible landing places; but we were unable to find a suitable spot, although we flew so low over the close-set villages that the natives, most of whom have never seen an airplane or even a wheeled vehicle of any sort except for the valley's single wheelbarrow, fled terrified for cover. It was necessary to make our first trip into the valley by the regular route over which, as we had by that time learned, such trade as the valley has with the outside world is carried on; that is, from Arequipa to Sumbay by rail, thence to Sibayo by motor truck, and from there on mule and horseback down to the town of Chivay in the upper valley. The whole trip, including an overnight stop at Sibayo, took about thirty hours.

Gradually we worked our way down the valley from Chivay to the village of Lari where with the help of one hundred sixty-five natives hired with six dollars worth of *chicha*, the native beer, we cleared and marked a landing field. While in the valley we lived in the houses of the natives and ate the native food—llama stew, potatoes, beans, and *chicha*. The wheat harvest had just been completed when we arrived, and before we left we had the good fortune to witness the threshing operations and got many feet of moving pictures of the process. Our one remaining plane—we had crippled the other on the way to Cuzco—flew over several times to drop mail, messages, and medicinal supplies and on one occasion picked up from the roof of the church at Chivay a message we were anxious to get off to New York. Four days—June 18 to 21—were spent in making oblique photographs of the Colca and Andagua valleys from the air. On June 22 and 24 we did our vertical photography for the map of the Colca Valley and on June 25 and 26

FIG. 4—The gorge of the Colca River near the village of Pinchollo.
FIG. 5—An oblique view of the volcano climbed by the expedition, an almost perfect cone.

FIG. 6

FIG. 7

FIG. 6—One of the vertical photographs from the aërial survey of the Colca Valley, showing the village of Lari surrounded by agricultural terraces and, at the right, the deep inner gorge of the Colca River.

FIG. 7—An oblique photograph of the village of Lari and the expedition's landing field. Gypsum from a near-by deposit was used for outlining the field, indicating "start" and "end" points, and marking the landing direction with large white arrows.

FIG. 8

FIG. 9

FIG. 8—The flat top of a river terrace near Cailloma completely covered with a patchwork of cultivated fields. Note also the terraces clinging to the steep walls of the inner gorge of the river.
FIG. 9—The village of Canacota in the upper Colca Valley.

FIG. 10

FIG. 11

FIG. 10—Chivay, the administrative center of the Colca Valley.
FIG. 11—The village of Ichupampa.

that for the map of the Andagua Valley (see Pl. IV). For the former two hundred and sixty-five photographs were made and for the latter two hundred and eighty-five.

The photographic work completed, we continued on down the valley from Lari to Cabanaconde, where we crossed the deep inner gorge of the Colca River and climbed out of the valley and over the 16,000-foot pass in the range that separates it from the Andagua Valley. Three more days on the trail brought us to the town of Andagua. After a brief examination of a small section of that valley we crossed over into the Andomayo Valley and followed it down to Aplao where automobiles were waiting to take us back to Arequipa. By the time we arrived there we had been twenty-eight days in the field.

Wool Exports from the Colca Valley

Chivay is the only town in the Colca Valley that has any regular, direct contact with the outside world. From there llama trains make regular trips in season with wool for the Arequipa market, and a small trading station is maintained where the people of the valley purchase the few articles of clothing and the few utensils that they import from the outside. There is also a not-altogether-dependable telephone connection between Chivay and Cailloma, the capital of the province, and several members of the Guardia Civil are regularly assigned to the village from their headquarters at Cailloma.

A surprisingly large amount of wool is transported from Chivay to Arequipa by llama trains, which either connect with the railway at Sumbay or make the trip direct to Arequipa. The manager of the trading station there informed us that about 80,000 pounds were sent to Arequipa from the valley each year and that an additional 20,000 pounds from the southern part of the department of Cuzco were also routed that way. Of this, three-fourths is pure alpaca wool, and the remainder is llama and sheep wool and a mixture called *huarizo*.

Flocks, Farms, and Fiestas

The flocks are kept on the sparse pasture lands of the plateau summit and are owned not by the people of the valley floor, as is frequently the case in similar agricultural communities in Peru, but by the shepherds themselves. The shepherds live the year around in sheltered nooks just within the upper edge of the valley, each family having its own grazing land marked off by piles of rocks. The flesh of the llama and the alpaca, dried in the sun until as hard as cement and boiled in stew until of the consistency of shoe leather, is the chief item in the diet of these shepherd Indians.

Wool is the only export from the upper valley; but some fruit is shipped to Arequipa from the lower, warmer section of the valley

below Cabanaconde. The wheat, barley, beans, corn, and potatoes grown in the valley are all consumed there. There are a few small herds of cattle on the valley floor but, like all of the livestock of the area—horses, mules, and burros, as well as cattle—they are small and scrawny.

The people of the valley, who are with few exceptions pure Indian, all own their own parcels of land apportioned to the various families by the colonial government, apparently when the villages were first reorganized by the Spaniards, and granted to them in perpetuity. Many of the families own a rather large total acreage; but, in such cases, the holdings are so broken up into small parcels and include so much uncultivable land that the actual property value is fairly evenly distributed among the various families.

The people of the various communities seem in general to live and work harmoniously. Several times we observed whole communities at work clearing the irrigation ditches, such occasions being in the nature of informal *fiestas*, livened by plenty of *chicha* and much dancing, with the result that the whole village turned out and worked willingly. A certain amount of intervillage rivalry was in evidence, presumably due to the fact that each village more or less specializes in some one home industry—one concentrating on weaving, another on bread making, another on *chicha*, another on the preparation of coca—whereas, actually, because of the difficulty of travel from village to village, each must be fairly self-sustaining.

Fiestas, of course, provide the only breaks in the monotony of existence in the valley. Every week there seemed to be one somewhere and it is quite the custom to follow them from village to village in off seasons when the crops have been gathered. The *fiestas* at the village of Callalli are of particular interest. The former inhabitants of the village were some years ago forced to abandon their original holdings because of lack of water for irrigation and moved to higher land at some distance from the village. Every family still, however, maintains its "town house" in Callalli, but the village is completely deserted except for some four or five times a year when the whole population returns for periods of never more than five days each. Mock bullfights are staged, *chicha* is consumed by the jugful, an open market does a thriving business, and the ancient church bells are rung day and night. Then the village is again deserted until the next *fiesta*.

Deserted Villages

Callalli is by no means the only deserted village in the valley. In fact, ruins are to be found everywhere, and a number of villages which, on Johnson's first view of them from the air, seemed to be completely inhabited proved to contain a large proportion of roofless, deserted

houses. Chivay, Lari, Cabanaconde, and Yanque are now the most fully occupied villages of the valley. There is one town in the upper valley near Sibayo, called San Juan by the natives, that is completely

FIG. 12—A village in the upper Colca Valley between Chivay and Sibayo, now completely in ruins, although the rectangular pattern of its streets shows it was laid out by the Spaniards.

in ruins, does not appear on any map, and is not mentioned in any document we have been able to find, although, judging from the area covered by the ruins, which include those of a tremendous church, this village must have been as large as any now standing in the valley. Still farther down the valley near Yanque is another deserted village almost lost in the maze of particularly high terraces that

surround it, although its regular layout of streets and houses indicates that it was of Spanish origin.

Numerous ruins of scattered Indian villages with tumbled houses

FIG. 13—The steep zigzag trail rising out of the gorge of the Colca River by which the expedition left the Colca Valley for the trip to the Andagua Valley. The village in the upper left corner is Llanca.

evidently conforming to no ordered plan, as distinguished from those laid out by the Spaniards, were also caught by the aerial camera even though we had failed to notice the majority of them during our work on the ground. At one place, between the villages of Maca and Pinchollo, the natives pointed out ancient cliff dwellings cut in the sheer rock cliff high up the side of the valley and accessible only with

scaling ladders, which may have been used by the Indians as a refuge from the Spaniards. On the opposite side of the valley near Lari we found, a thousand feet or more above the valley floor, a number of burial caves which had evidently been recently looted but still contained hundreds of skeletons. That none of the skulls examined were deformed—said to have been a practice of the inhabitants before the coming of the Spaniards—seemed to indicate that the people buried there were of a period at least a generation after the Spanish conquest of the valley.

Causes of Depopulation

It would seem, from the number of completely deserted villages and the many deserted houses in others, that the valley had a much larger population, at least during the colonial period, than it has at present. There are stories in the valley of famines, plagues, and earthquakes that made heavy inroads on the population. It is probable, also, that many succumbed to the hard labor in the mines at Cailloma. It is said, moreover, that many left the valley from time to time for new land elsewhere and either never returned or else came back bringing fevers and other diseases contracted in the lowlands. Incidentally, this emigration still continues to a fairly large extent. At any rate the whole story of the people of the valley from the time of the Conquest down to fairly recent times seems to have been no less sad than that of most of the aboriginal inhabitants of the Andean countries under the republics as well as in colonial times; and it is surprising that the present-day inhabitants are such a cheerful, hospitable, hard-working people as distinguished from the sullen, suspicious, and even hostile Indians found in many parts of the Andes of Peru and Bolivia. Undoubtedly the fact that since early in the colonial period they have owned their own land and been free from the *colono* system or other systems of semi-slavery prevalent in the Andean countries has had much to do with this attitude. Today the population of the valley is said to be once more distinctly on the increase. The largest town of the valley today is Cabanaconde, with some 1500 inhabitants, and the smallest is Corporaque with perhaps 200.

Early History

Mr. Philip Ainsworth Means has been kind enough to furnish the writer with the results of his recent studies of such documents dealing with the Colca Valley as he has been able to find. Among the most important of these is a report written by Juan de Ulloa Mongollón, corregidor of the province of the Collaguas and Cabanaconde, and signed at Yanque on January 20, 1586. The document is a report in response to an order from the viceroy, Fernando de Torres y Portu-

gal, who had received from Philip II a series of questionnaires designed to provide the king with first-hand information concerning his possessions in America.

According to this document, the people of the upper valley were the Collahuas, or Collaguas, whose legendary origin was in a snow-covered

FIG. 14—The edge of the village of Corporaque is shown in the upper right corner of this photograph. In the center is one of the ruins of circular structures found at a number of prominent points in the Colca Valley. They are of the piled-rock construction known as *chulpa* and were evidently fortified watch-towers since each is so placed as to command a view of a considerable section of the valley.

conical volcano in the neighboring province of Vellilli called Collaguata, whence they invaded the valley, driving out the original inhabitants and establishing themselves there, while the people of the lower valley came from a snow-capped mountain called Gualcagualca and founded the village of Cabanaconde. The document clearly indicates that at the time it was written the valley had a considerable population. The province of "Yanqui Collagua" had 4000 married, tribute-paying Indians, which fact, according to Mr. Means, implies a population of about 20,000; "Lare Collagua" (the present community centering in the village of Lari) had about 2500 tribute-paying Indians, or 12,500 inhabitants; and Cavana (the district centering in the village now called Cabanaconde) had about 8200 inhabitants. When the viceroy Francisco de Toledo first visited the valley (between 1570 and 1575) the Indians there were settled in many small hamlets. He gathered them together into larger villages, evidently those they occupy today.

According to various documents examined by Mr. Means, particularly the writings of Garcilaso de la Vega and Father Bernabé Cobo, the Collahuas were brought into the Inca empire by the Inca Mayta Capac who ruled about 1195 to 1230 and who not only carried on extensive campaigns against them but also, having conquered them,

FIG. 15—Rock bastions in the upper Colca Valley near Callalli.

married a daughter of their chief. Father Cobo writes that the people of the valley in consequence of the union of their royal house with that of the Inca "made for the service of these sovereigns a house all of copper for them to lodge in when they came to visit the relatives of the queen. A part of this copper was found through the diligence of the friars of San Francisco who have the religious instruction of that province, and from it they made four great bells; and of the part that is wanting the Indians say that they had given it to Gonzalo Pizarro and his army in the time of the civil wars."

The churches of the Colca Valley, which, as is usual in South America, are out of all proportion to the size of the villages, were built and adorned by the friars of San Francisco. Later, for reasons unknown, the friars were returned to their monasteries. At any rate, when the document of 1586 was written the valley belonged to the diocese of Cuzco, and every one of the towns had a church and a priest appointed by the viceroy on behalf of the Spanish Crown.

In several of the churches we found statues of Philip II as well as other statues that seemed to be of the same period. This, together

with the testimony of the documents examined by Mr. Means, as well as certain legends still current in the valley, would seem to indicate that the villages were established during his reign. They conform, moreover, in almost all respects—the arrangement of the plazas with the churches slightly raised and blocked off from them,

FIG. 16—A small, isolated volcano high up on the Colca side of the range that separates that valley from the Andagua Valley.

the rectangular layout of the streets, etc.—to the detailed specifications given out under his authority in 1573 for the design of new towns in his American possessions.

SURVIVAL OF PAGAN BELIEFS

The friars of San Francisco, who did the pioneer work in converting the people of the valley to Christianity, must have had a long struggle to wean them away from their pagan beliefs, judging from the many ancient superstitions and customs which they still retain. A good example of these is the *apacheta*, a propitiatory offering to the gods common throughout Peru and Bolivia: coca quids are thrown against the rocks to assure safe passage for men and beasts at a point on the trail from Chivay to Lari where mules can just squeeze along the rock wall hundreds of feet above the swirling waters of the Colca. Again, at one of the community ditch-digging affairs we noticed a peculiar standard placed at a point where it could be seen by all and guarded by several natives. Silver plates and curiously twisted and hammered

bars formed an intricate, triangular ornament mounted on a silver staff. Its purpose was not clear, and we could get no information concerning it from the people.

Political Administration

Before the rediscovery of the mines at Cailloma, Yanque was the local administrative center of the Colca Valley but was then supplanted by Chivay, probably because of easier access of that village from Cailloma which became the capital of the province. The system of control prescribed for the communities is admirable in theory; but in practice, as elsewhere in Peru, it falls far short of perfection. Each village has a governor (supposedly someone who has been in Arequipa, has some education, and is well versed in his duties) who controls the village through an alcalde, or native mayor. Priests, each with not more than three villages under his charge, are to supervise the religious instruction. Police duty is to be the office of the Guardia Civil, a squad of which is to be stationed at Chivay under a second lieutenant. Military conscription is to be in charge of a military guard in Chivay under a first lieutenant, who has a special clerk for the conscription lists. All official matters of importance are to be referred to a judge at Cailloma, who is, in turn, under the supreme judge at Arequipa. All grave questions of administration are to be decided by the subprefect at Cailloma or the prefect at Arequipa. An inspector of schools is to reside at Chivay; and this village is to be the center of instruction for the valley, since the provincial capital is too far away.

Actually, however, the governors are of low intelligence, and the alcaldes show little if any interest in the machinery of government. The result is that the Guardia Civil and the military guard seem to have more control over local affairs than do the civil officers. The three or four priests now in the valley are unambitious and indifferent and hold services only when they feel so inclined. The inspector of schools is a mere youngster who can barely speak good Spanish and is even less capable of writing it. Lari is perhaps the best-governed village of the valley; the governor, when we were there, was a political refugee from Cailloma, where he had been an important official under the Leguia régime, and had appointed himself to the position.

The people of the valley half-heartedly maintain that Chivay and not Cailloma should be the capital of the province, although why, except as a matter of convenience to themselves, was not clear. One reason may be that the marriage laws of the country require that the marriage ceremony be performed at the provincial capital, with the result that, since it is a long journey from the valley to Cailloma, the inhabitants have simply dispensed with the ceremony.

FIG. 17

FIG. 18

FIG. 17—A lake formed by the damming of the Andagua River by a lava flow. For location see center of upper edge of the mosaic, Plate IV.

FIG. 18—The twin volcanoes near the town of Andagua.

The Andagua Valley and Its Volcanoes

We consider our photographs and mosaic map of the Andagua Valley scarcely less interesting than our discovery of the great wall of the Santa Valley. Our interest in it was first aroused when we flew over it during one of our reconnaissance flights over the Colca Valley and noticed, rising from the valley floor, a large number of what appeared to be small volcanoes, although we could not recall any mention of them in the literature on that section of Peru. We determined, therefore, to study the valley on the ground and map it from the air if time permitted.

Because of lack of time our exploration of the valley on the ground covered only a small section—about twelve miles in length extending down the valley from the town of Andagua. There we made numerous photographs, laid out ground control for our aerial survey, and took careful measurements of the most perfect cone in the valley, ascending it and camping overnight in its crater. This cone measured 460 feet in height and 1600 feet in diameter at its base, with sides sloping upward at an angle of about 48 degrees to a crater 350 feet in diameter at the rim, 65 feet in depth, and 90 feet in diameter at the bottom. Dense growths of cacti covered not only the flanks of the cone but also the interior of the crater.

It is impossible to state, without further examination of the photographs made for our mosaic map, just how many volcanoes there are in the valley. Many of them have been so blown to pieces and their flows so merged that they appear as volcanoes only when studied closely under the stereoscope. So far we have located about forty. The valley proper is about eighty kilometers long, and practically the whole of its floor is covered by lava flows, although in several sections there is terraced land, some still cultivated but much now abandoned, along the sides of the valley. The depth of the lava varies greatly. In some places it is only twenty to twenty-five feet deep and in others at least twice that depth. Most of it is coal black, but there are some sections that have a more grayish hue. Judging from their more disintegrated character and the greater effect of erosion on their lava flows, the volcanoes of the upper part of the valley are much older than those of the lower valley. Even within these sections the volcanoes seem to differ considerably in age, or at least their most recent activity has been at different times, for in some the cactus growth is dense and tall, while in others it is scarcely established, and others are completely bare.

We were greatly surprised to find that even the natives did not realize that the valley contained so many volcanoes. Most of them recognized only two as such—the twin volcanoes near the town of Andagua. The explanation is, however, obvious. With no particular

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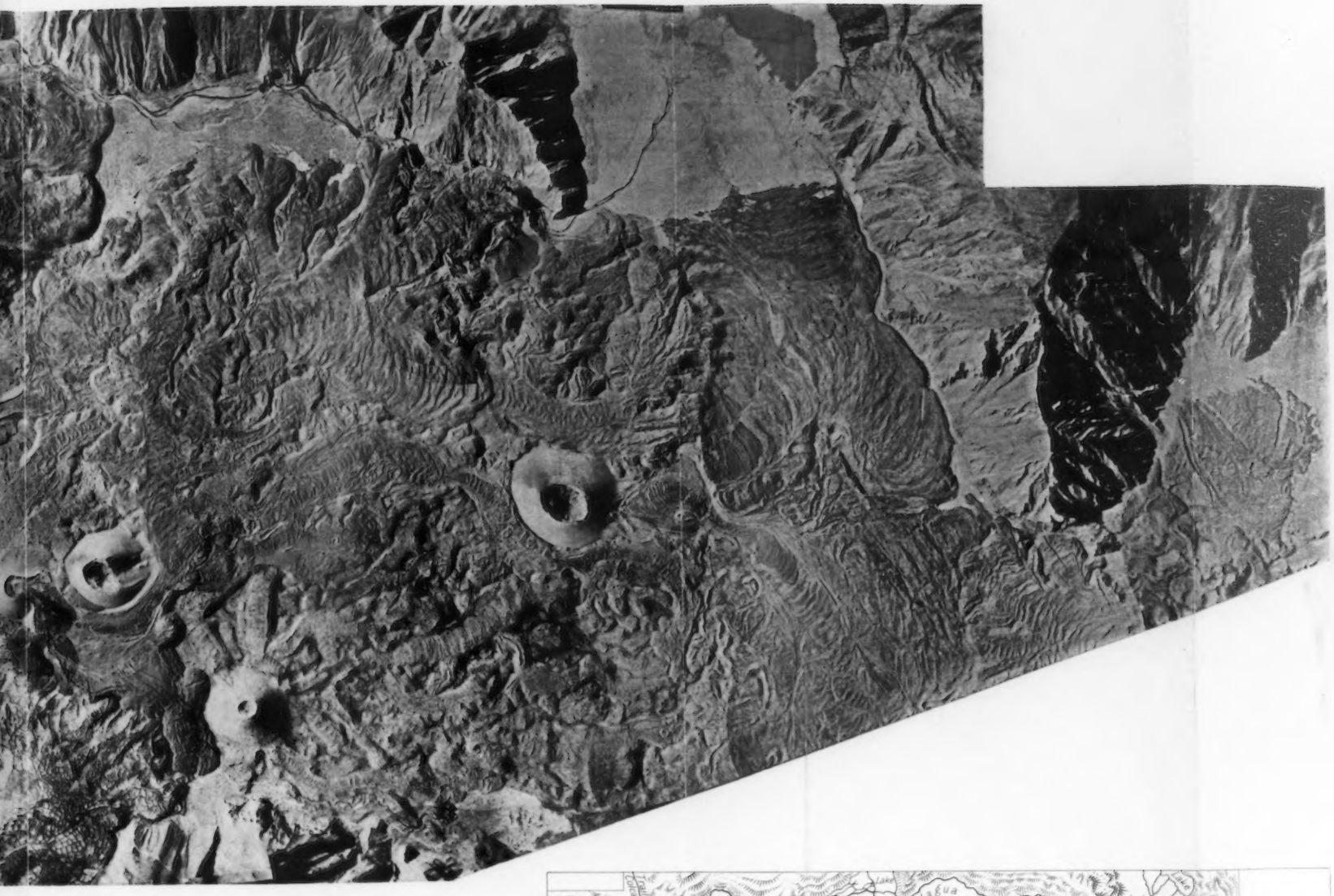
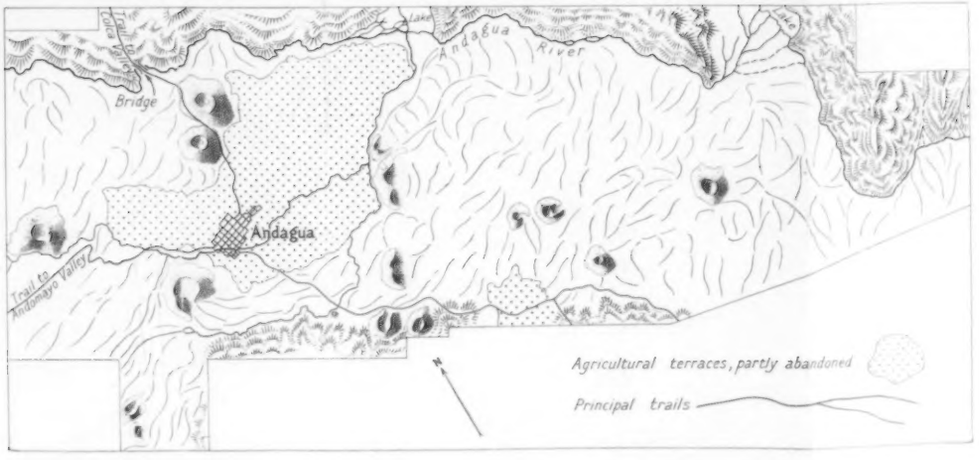
Mosaic of a section of the Andagua Valley, Peru, made up of vertic
taken in the aërial survey of the valley. Sixteen volcanoes have been
mosaic as shown on the accompanying location map. The lava flows
the tributary of the Andagua River that flows through the town of A
to be much older than those to the right of this stream. The agricu
now partly abandoned appear to be all on the older lava flows. Note
at the upper edge of the mosaic formed by the damming of the Andagua
flows. Scale of mosaic 1 inch to 2700 feet.





up of vertical photographs
have been located in this
e lava flows at the left of
town of Andagua appear
The agricultural terraces,
ows. Note the two lakes
he Andagua River by lava

UNIV. OF MICH.

reason for climbing to the top of any of the mounds where a glimpse of their craters would have made their true character immediately apparent, they thought them all mere hills. It is strange, however, that so interesting a phenomenon has apparently never caught the eye of a geologist or any other person capable of recognizing them for what they are. Several exploring expeditions have passed close by at different times but missed the valley because they were not able to see over the bordering mountains. As was the case with our discovery of the great wall, our spotting of this valley from the air is only further proof of the value of the airplane and the aerial camera in exploration.

Andagua, the principal town of the valley, lies at an elevation of 11,450 feet above the sea and has a population of about 1200. It appears that the whole valley has a much smaller population now than earlier. It may be that the eruption of the volcanoes had something to do with this apparent depopulation, since in places it appears that the most recent lava flows have partly covered sections of agricultural terraces. At any rate in many sections the terraces have been abandoned, and only enough are now in use to provide food for the local inhabitants and fodder for their cattle. Herds of cattle of considerable size are kept in the upper valley, and the driving of these cattle to the coast is the only contact that the people of the valley have with the outside world.

It is almost impossible to travel straight down the valley to its junction with the Colca or upper Majes Valley. The only bridge across the deep, inner gorge of the river is an ancient stone bridge just above the town of Andagua, and elsewhere the descents to the present bed of the river are so steep that fording is quite out of the question. The result is that cattle have to be driven out of the valley by the route we followed in leaving it: that is, over a 17,000-foot pass to the Andomayo Valley and thence by that valley and the Majes Valley to the coast at Camaná. The hardships of this route so "lean out" the cattle that numerous stops for grazing must be made in the Andomayo Valley, for which the herdsmen have to pay heavily to the owners of the pasture lands.

SUNSET CRATER*

THE EFFECT OF A VOLCANIC ERUPTION ON AN ANCIENT PUEBLO PEOPLE

Harold S. Colton

Museum of Northern Arizona

IN northern Arizona two hundred or more recent cinder cones surround the San Francisco Peaks. Among these cones none is as striking as Sunset Crater (Fig. 1). Rising above an awe-inspiring flow of fresh-looking lava, its ruddy rim glows as in the rays of a perpetually setting sun. So interesting are its surroundings and so remarkable its scenery that, in 1930, it was proclaimed a National Monument.

But Sunset Crater is distinguished in other ways. It is the most recent vent of the volcanic field in which it lies.[1] In 1930 the archeological expedition of the Museum of Northern Arizona discovered the dwellings of an ancient people of pueblo culture buried under its ash. Thus a method is afforded by which the eruption may be dated. Moreover, it is clear that the outburst played a leading rôle in the economic development of the region in a certain period of prehistoric times.

In 1916 the author began an archeological survey of the area. On plotting the data it became evident that sites a few miles east of the San Francisco Peaks were much more abundant than in regions of similar altitude, rainfall, drainage, and soil conditions elsewhere.[2] Apparently the great increase in population occurred between 1000 and 1200 A.D. Before the former date few people lived on the lava flows east of the peaks, and after 1200 the country became almost deserted—a puzzling condition that called for explanation. Various hypotheses were considered and rejected. The archeological expeditions of the Museum of Northern Arizona have indicated that Sunset Crater furnishes the key.

*In the preparation of this paper the author is indebted to Katharine Bartlett, Lyndon L. Hargrave, and John C. McGregor, members of the staff of the Museum of Northern Arizona.

[1] Next in recency to Sunset Crater is "S. P.," lying north of the San Francisco Peaks. This crater was examined and described by Professor Douglas Johnson a number of years ago. On the basis of a comparison with photographs of the cone "locally known as Sunset Mountain" he expressed the opinion that the latter (Sunset Crater) was the older (A Recent Volcano in the San Francisco Mountain Region, Arizona, *Bull. Geogr. Soc. of Philadelphia*, Vol. 5, 1907, pp. 146–151). The condition of the surface of the flow, the oxidation of the ash fall, and its reduction in part to clay supporting a good growth of grass establish the greater age of S. P. Crater, perhaps by a thousand years or more.

[2] H. S. Colton: A Survey of Prehistoric Sites in the Region of Flagstaff, Arizona, *Bur. of Amer. Ethnology Bull. 104*, Washington, 1932, p. 66.

Dating the Eruption

In this part of northern Arizona styles in the manufacturing of pottery have changed rapidly. The chronological sequence of styles is well known, a dozen or more ceramic periods, one merging into another being recognized. In the period called Pueblo II we find

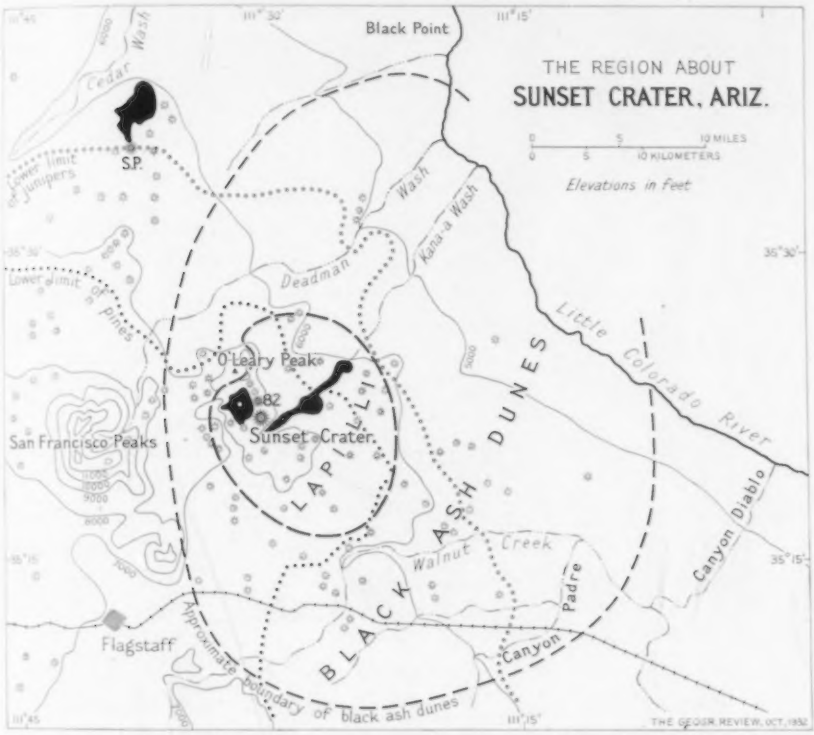


FIG. 1—Map of the region about Sunset Crater. The principal cinder cones are shown, the lava flows (solid black), and the areas of heavier and lighter ash fall from the Sunset eruption (heavy broken lines). The effect of the ash on the lower limits of pine and juniper is also indicated. Scale of map 1:675,000.

sites covered by volcanic ash and also sites without the ash cover. Therefore we believe that the eruption of Sunset Crater fell within the period Pueblo II.

From sites buried by volcanic ash and from sites without the ash cover Mr. Lyndon L. Hargrave,[3] in charge of the archeological expedition of the Museum, has painstakingly gathered charred wood and carbonized planks and timbers. The material has been submitted to Dr. A. E. Douglass and J. C. McGregor. By the Douglass tree-ring

[3] L. L. Hargrave: Prehistoric Earth Lodges of the San Francisco Mountains, *Museum of Northern Arizona Notes*, Vol. 3, No. 5, Flagstaff, 1930.

Idem: Museum of Northern Arizona Archaeological Expedition of 1931, *ibid.*, Vol. 4, No. 5, 1931.

Idem: Guide to Forty Pottery Types from the Hopi Country and the San Francisco Mountains, Arizona, *Museum of Northern Arizona, Bull. No. 1*, 1932.

method[4] they have dated a number of the posteruptive sites. These sites were occupied between 875 and 1276 A.D. The preëruptive sites have not been dated because of the poor quality and scarcity of the charcoal recovered. As some of the preëruptive sites show little erosion before the ash fall, they cannot have been deserted long before the eruption. It may be safely assumed that the eruption of Sunset Crater took place some time after 700 and before 875 A.D. The Hopi Indians who dwell at Oraibi some sixty miles west of the crater have a tradition that may possibly perpetuate a dim memory of the event.[5]

Distribution of Ash

East of the San Francisco Peaks the land slopes down to the Little Colorado River 100 feet to the mile. Here the original surface rock, the light-colored Kaibab Limestone, has, in most places, been overlain by flows of black basalt and beds of ash. Where not forested it is a breezy, grassy steppe. Besides the Little Colorado River the red Moenkopi Sandstone overlies the Kaibab Limestone. It is a barren region of low red mesas and small sandy washes. At present the entire area is uninhabited except for a few Navajos by the river and a few white ranches close to the San Francisco Peaks.

Long before the eruption of Sunset Crater the original drainage, which followed canyons in the limestone plateau, was obstructed by cinder cones and their lava flows, so secondary or consequent drainages were established. One such agglomeration of cones, called by Robinson[6] "the Black Hills," but better known to the inhabitants of Flagstaff as the Cinder Hills, caused the establishment of a secondary drainage through Bonito Park around the south side of Crater No. 82[7] and thence northeast to the Little Colorado River. This drainage we may call Kan-a-a Wash. In the yellow oxidized ash that covered the lava terraces on the upper part of the Kan-a-a Wash early pueblo people dug their pit houses. More than twenty-five early sites have been recorded.

In a line across Kan-a-a Wash northwest to southeast opened a fissure which we have traced for four miles. From this fissure material was ejected sufficient to build the cone of Sunset, 1000 feet high, supply two lava flows, build up a number of fumaroles, and cover the ground for miles around with black basaltic sand (ash or, where

[4] A. E. Douglass: The Secret of the Southwest Solved by Talkative Tree Rings, *Natl. Geogr. Mag.*, Vol. 56, 1929, pp. 737–770.

J. C. McGregor: Tree Ring Dating, *Museum of Northern Arizona Notes*, Vol. 3, No. 4, Flagstaff, 1930.

[5] H. R. Voth: The Traditions of the Hopi, *Field Museum of Nat. Hist. Publ. 96 (Anthropol. Ser.*, Vol. 8), 1905, p. 243.

[6] H. H. Robinson: The San Franciscan Volcanic Field, Arizona, *U. S. Geol. Survey Professional Paper 76*, Washington, 1913.

[7] Since few of the craters have names the volcanic survey of the Museum of Northern Arizona has given them numbers: 185 vents lie in the region covered by this paper.

the fragments are from one fourth to an inch in diameter, lapilli or cinders).

The eastern lava flow seems to have been the earlier, because it is covered with deep ash and cinders. Issuing from the south base of Sunset it followed down Kan-a-a Wash Valley about seven miles. In one place it spread into a lake a mile wide and in another tumbled down a steep declivity. This may be called the Kan-a-a Flow.

The northwestern flow, called by Robinson the Bonito Flow, has had a different history. Sunset Crater now blocked the drainage of Kan-a-a Valley and formed an intercone basin into which the basalt poured, creating a lake roughly circular and about two miles in diameter. About half the lake was formed before the crater ceased to spout ash so that, like the Kan-a-a Flow, it is covered with black sand, lapilli, and scoria. Near the edges the surface is fissured, the fissures being filled with basaltic masses to which the term "squeeze ups," or anosma, has been applied.[8] These form the

[8] H. S. Colton and C. F. Park, Jr.: Anosma or "Squeeze-Ups," *Science*, Vol. 72 (N.S.), 1930, p. 579.

H. S. Colton: Sunset Crater and the Lava Beds, *Museum of Northern Arizona Notes*, Vol. 2, No. 4, Flagstaff, 1929.

FIG. 2

FIG. 3

FIG. 4

FIG. 2—The striking cone of Sunset Crater.

FIG. 3—Looking towards the south face of Sunset Crater over cinder-covered hills and valleys.

FIG. 4—Canyon Padre below its junction with Walnut Creek. The latter stream contributes a heavy burden of black volcanic sand.

point of origin of secondary flows which are not ash-covered. The lava flow is peculiar in another way. The surface is covered with fumaroles, and the basalt has been oxidized red by hot steam acting over a considerable time. Evidently the activity of Sunset Crater passed through several phases.

Not only was lava poured forth on the surface, but black basaltic sand (ash) was scattered over a wide area—roughly elliptical with

FIG. 5

FIG. 6

FIG. 5—Pit house of Pueblo II age, partially excavated. The Indian stands on the clay floor above which lies the clay of the fallen roof. The section shows the bottom of the original depression at the Indian's left hand filled with layers of lapilli separated by lenses of wind-blown ash. The depth of the depression shows that a short interval lapsed between abandonment of the pit house and the eruption.

FIG. 6—An older pit-house depression, Pueblo I age, which was filled with débris before the lapilli fell, indicating a long interval between abandonment of the house and the eruption.

a north-south axis of about thirty-six miles and east-west axis of about twenty-eight miles (Fig. 1). Within this larger oval lies a smaller circular area about twelve miles in diameter in which the volcanic débris still covers the ground with a black mantle of material too large to be moved by the wind. However, on exposed hilltops high winds and heavy rains have carried away even the coarse lapilli, and nearly all the black cinder-covered hills show yellow crests. Outside the inner area the sand grains are smaller, and the ash has been drifted into dunes or blown into canyons, the surface of the ground in general being clear of black sand. It is this ash fall that seems to have had such an important effect on the activities of the prehistoric peoples of the plateau.

Excavation of the prehistoric pit houses mentioned above has exposed instructive sections of the ash. Northwest of the crater two miles, several pit houses were excavated which had apparently been in ruins for only a short while before the eruption. The clay roof lay directly on the floor, on which no black sand was visible; but in the middle of the depression the sand lay directly on the clay of

the roof. In contrast to this condition other pit houses have been excavated, in which much débris lay between the roof clay and the black sand. Such sites had evidently been deserted long before the eruption and in most cases the pottery they yielded is of Pueblo I period.

It is difficult to recognize preëruptive sites in the cinder-covered area. The depression caused by the collapse of the walls of the pit house becomes completely filled so that the ground is level. All sherds that were lying on the surface of the ground are buried by a foot of ash and lapilli. It is fortunate for us that pines flourish in this area and that high winds frequently uproot them. In the roots sherds are carried to the surface of the ground and are left when the tree rots away. Over thirty-six sites have been discovered under the ash, and twenty-four pit houses have been completely or in part excavated.

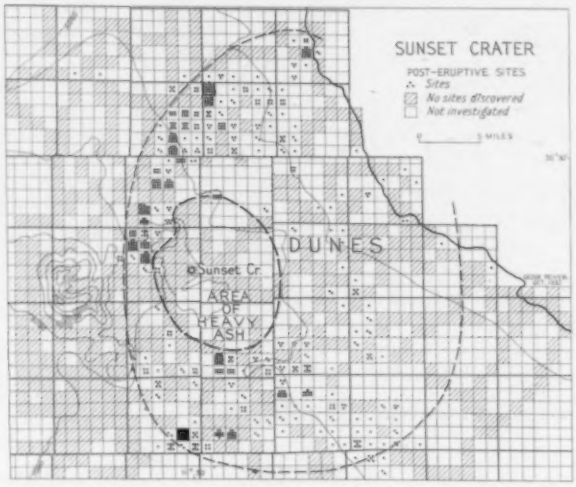


FIG. 7—Map showing the distribution of posteruptive sites in relation to the distribution of volcanic ash.

DISTRIBUTION OF PREHISTORIC SITES

The maps, Figures 7, 8, and 9, illustrate the distribution of prehistoric sites in the region. By surface indications all the earlier sites of Pueblo I and the preceding Basket Maker III are classed as preëruptive because in every case excavated the sites are overlain by basaltic sand. The determination of preëruptive Pueblo II sites is not so clear-cut. Some have been determined by excavation, others by the presence of the pottery type shown as "Deadman's Black-on-Red" and the absence of corrugated wares. Excavations show that about the time of the eruption of Sunset Crater Deadman's Black-on-Red, a ware with a sand temper, was replaced by Tusayan Black-on-Red, a ware with a sherd temper; and about that time corrugated wares were introduced.

It is seen that the preëruptive sites lie among the cinder hills and on the alluvial fans south and east of the Peaks. Posteruptive sites

of late Pueblo II and early Pueblo III are much more numerous and are confined to the area where dunes of black basaltic sand are still found. The posteruptive sites are particularly numerous on the periphery of the ash-fall area, i.e. where the material was finest. They are fewer in the more central area, where the sand was coarser. Sites are absent in the region of coarse lapilli and scarce in the area

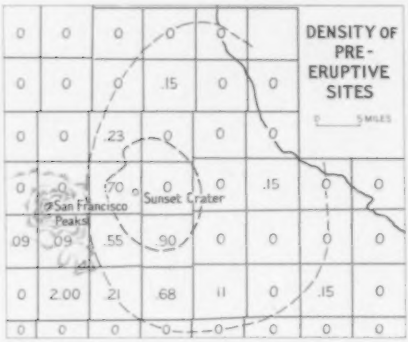


FIG. 8

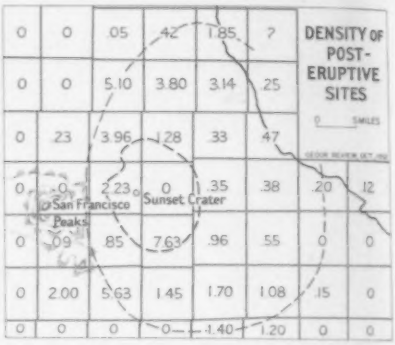


FIG. 9

FIGS. 8 and 9—Maps showing the relative density of preëruptive and posteruptive sites respectively. The density is arrived at by dividing the number of sites found in a township by the number of sections traversed and explored.

where the ash did not fall. Middle and late Pueblo III sites are scarce and are confined to three medium-sized pueblos, Elden, Turkey Hill, and Old Caves near the alluvial fans of the Peaks, and one, Wupatki, near the Little Colorado.

HOPI METHODS OF AGRICULTURE

When Hopi methods of agriculture are studied, the significance of the distribution of the prehistoric peoples becomes clear. Maize was the principal crop and alone will be considered here, although beans and squash were also important food products. The same crops are raised today by the Hopi, who probably carry the blood of these ancient people and who have in any case inherited their culture.

The Hopi use several methods in the cultivation of maize. One method makes use of the dunes that cover a large part of the present Hopi country. The dunes are commonly shallow—six inches to two feet deep—and cover several acres and travel with the prevailing westerly winds. Such moving fields caused the Indian Bureau much trouble in the 1890's, when they tried to allot the land to individual Indians. The Hopi with his foot scrapes a shallow basin in the dunes and with his digging stick makes a long narrow hole down to the sandy loam beneath. The hole may be from six to eighteen inches

deep, for the Hopi maize is a special variety adapted to arid conditions.[9] Deep planting allows the seed to germinate in moist soil, for the sand layer is poor in capillary action and forms a mulch, conserving the moisture in the underlying loam.

Figure 7 shows that the distribution of a dense population, late Pueblo II and early Pueblo III in time, corresponds with the distribution of Sunset ash dunes. Since it is found in the ash-fall area alone and not north or south in similar soil conditions, altitudes, or exposures, it is evident that the ash fall was somehow responsible. The nature of Hopi agriculture offers an explanation. The black sand formed a mulch, conserved the moisture, and made agriculture possible where it had not been possible before. Population flowed into the ash-covered area from about 1000 A.D. and flourished for about two hundred years.

But the westerly winds, which blow so strongly on those grassy steppes in May and June, gradually removed the fine-sand cover from most of the populated area. The winds piled the sand into dunes too deep for Hopi maize. They drifted the sand into the limestone canyons in great black banks, whence the intermittent streams carried much of it away. They collected the sand in drifts below escarpments and on the lee side of cinder cones. The winds, therefore, are part of the story.

With the departure of the sand the population seems to have dwindled. Lines of stones crossing little valleys or on lava or sandstone ridges show how the ancient people attempted to anchor their dunes, just as the Hopi today endeavor to prevent the sand mulch from leaving their fields. By the year 1200 most of the people had departed. From 1200 to 1300 four medium-sized pueblos struggled on. After 1300 the pueblo people abandoned this region as their home. However, they did not altogether forget it, and Hopi traditions continue to center about the Peaks. Occasional potsherds tell of ceremonial visits or hunting parties in the intervening centuries, and the Hopis still visit the San Francisco Peaks for their spiritual affairs.

The Ash Fall and Vegetation

In the past not only did the ash fall influence the distribution of man, but it still has an influence on the distribution of vegetation, which can be observed by following (Fig. 1) the lower limit of the western yellow pine (*Pinus ponderosa*) and the lower limit of the juniper (*Juniperus monosperma*). Among the craters to the north of the San Francisco Peaks the lower limit of the pine, on more or

[9] G. N. Collins: A Drought Resisting Adaptation in Seedlings of Hopi Maize, *Journ. Agric. Research*, Vol. 1, 1913–14, pp. 293–302. See also H. E. Gregory: The Navajo Country, *Bull. Amer. Geogr. Soc.*, Vol. 47, 1915, pp. 561–577 and 652–672; J. W. Hoover: Tusayan: The Hopi Indian Country of Arizona, *Geogr. Rev.*, Vol. 20, 1930, pp. 425–444.

less level ground, follows the 7000-foot contour line. South of the San Francisco Peaks the same is true. East of the peaks, in the area still covered by deep lapilli from Sunset Crater, the lower limit of the pine dips to the 6000-foot contour line. The effect of the ash fall on the juniper is not so apparent, for in the juniper zone much of the ash has been removed; but junipers are also found in one place 1000 feet below the general level.

Studies by Mr. J. C. McGregor show that the pines on the cinder fields have wide rings, which indicate abundant moisture. This is not strange when we consider that every drop of water from rain or melting snow enters the soil; there is no run-off, and the black sand or cinder cover prevents evaporation. The effect of the distribution of the trees confirms the conclusion based on agriculture—that the cinders form a mulch, valuable to plants.

The Ash Fall and Water Supply

One of the striking features of the west side of the Little Colorado Valley in the neighborhood of Flagstaff is the scarcity of water in regions remote from the river. The underlying rock is the Kaibab Limestone covered, in some places, with thin layers of Moenkopi Sandstone and, in other places, with basaltic lava flows. Except for the Moenkopi, which bears a few shaley layers, the rocks are porous; and not one of the streams has a permanent flow of water. In Walnut Creek several permanent water holes exist in basaltic canyons. Four springs seep from the Moenkopi Sandstone near the 5000-foot contour line. About the base of the peaks are a few small springs. Several other springs now dry can be located by deposits of potsherds.

Much of the area covered by the ash fall bears a good stand of grass. Because of the lack of drinking water, the area cannot be used for grazing and is now totally uninhabited by man. In the eleventh and twelfth centuries parts of this waterless area bore a dense human population. For these areas to the northeast of the San Francisco Peaks we can hardly escape from the conclusion that their springs have dried up or are buried under deep deposits of wind-blown black basaltic sand. Since several springs seeped water in the tenth and eleventh centuries, as may be inferred from the pottery fragments scattered about, it may be concluded that the annual rainfall is less. Although increasing aridity may account for the failure of certain springs, yet others may still be seeping under the great banks of basaltic sand.

QUATERNARY CLIMATIC CHANGES WITHIN THE TARIM BASIN

Erik Norin

DURING the autumn and winter of 1930, acting under the instructions of Dr. Sven Hedin,[1] the writer was engaged in a preliminary reconnaissance in the foothills of the Kunlun. The object of the survey was a search for Quaternary deposits, which might be expected to occur there, and the determination of the rate of recession of the late Quaternary glaciers, especially because of the bearing of the question on the much debated "desiccation" of the Tarim basin during the last two millenniums. Whilst the fieldwork was not then completed and the results can only be stated in tentative form, the writer ventures to publish this preliminary statement in the hope that it may draw the attention of other travelers in eastern Turkestan to these problems and he may benefit from their criticisms.

It is strange that no evidences of submontane moraines of Quaternary age have been recorded from the southern margin of the Tarim basin. The huge quantities of Quaternary sediments in the basin and the abundant evidences of former extensive glaciation in the southern Himalayas, where at places the glaciers reached the plains, induce us to expect similar conditions here also.

Submontane Moraines of the Duwa Region

With great expectancy I started my search for ancient moraines outside the mouth of the principal valleys along the foot of the Kunlun but without result until I finally made a systematic survey between Khotan and Sanju. Here I found typical morainic deposits at several places. The remains of these deposits seem confined to the mouths of small valleys carrying little or no water and to the lands along the foothills where the moraines have been protected from the erosion of the larger rivers. Such moraines have been discovered between the Karakash and the Duwa rivers and outside the mouth of the Sanju Valley. The first-named area—conveniently distinguished as the Duwa-kir area—is the most instructive. The border of the Kunlun block consists here of a syncline of red Tertiary sediments some ten kilometers broad, and to this syncline the morainic deposits are confined (Figs. 1 and 3). The syncline and the enclosed moraine

[1] On the Sino-Swedish Expedition see Dr. Hedin's book "Auf grosser Fahrt," 1929 (reviewed in *Geogr. Rev.*, Vol. 19, 1929, pp. 694-696; English version, "Across the Gobi Desert," 1932).

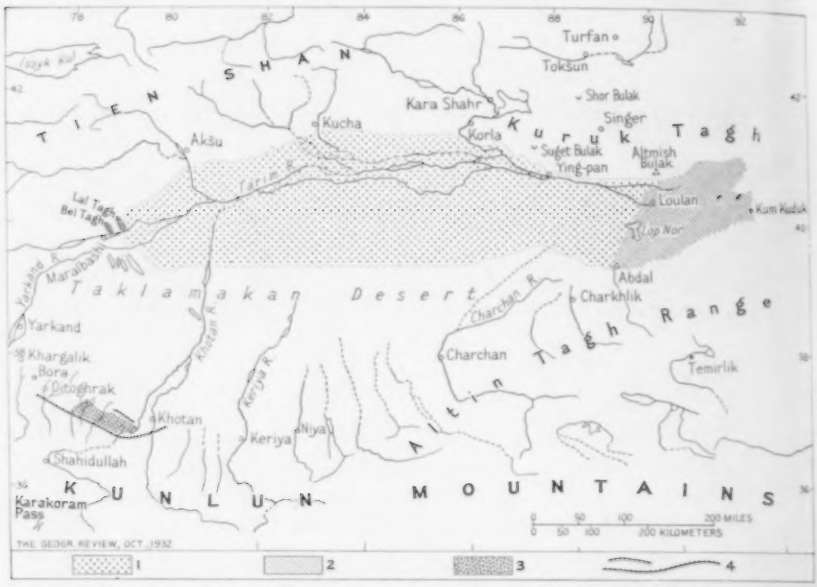


FIG. 1—Sketch map of the Tarim basin showing: 1, late-glacial sediments, mainly lacustrine; 2, approximate area covered by the first lake of Lop, formed after the sedimentary filling of the western part of the lake basin; 3, moraines of the maximum glaciation in the Duwa-Sanju area; 4, syncline of Tertiary sediments in the Duwa-Sanju area. See Fig. 2 for the Duwa-Sanju area on a larger scale. Scale of map approximately 1:12,500,000.

are separated from the Kunlun block by a zone of disturbance along which the Tertiary sediments border grayish-green slates and dark Carboniferous limestones.

The moraine forms a ridge called Yagme Tagh, which extends from the village of Duwa to a point about ten kilometers eastwards, where it becomes covered with fluviatile sediments. The ridge is three to five kilometers broad and reaches a maximum height of 325 meters above the surrounding Tertiary surface. It possesses all the characteristics of a typical moraine—a mass of unassorted boulders and blocks and gravel of all sizes, the largest boulders measuring four meters in diameter. The boulders are generally irregular but smoothed and rounded in outline, sometimes also showing beautiful, glacial striation. The rock fragments, gray gravelly sandstones, shales, and dark limestones, are exclusively of Carboniferous age. Granitic fragments,

FIG. 2—Sketch map of the Duwa-Sanju area on a scale of approximately 1:3,000,000.

FIG. 3

FIG. 4

FIG. 5

FIG. 3—Vaghme Tagh as seen from the west. The dotted line indicates the boundary between the morainic (higher) and the Tertiary (lower) deposits.

FIG. 4—The border mountains of the Kunlun at the village of Langru, south of Khotan. To the right the Tertiary sediments of the Tawak-kir plateau, which are separated from the mountains by a recent dislocation line.

FIG. 5—The Karakash Valley above Kok-boinak (see Fig. 2).

which are very characteristic of the Karakash Valley, are entirely missing. The glaciers that deposited this moraine must have belonged to the Duwa Valley system, forming a wide lobe on the foreland of that time. The present altitude of the bottom of the Duwa moraine is about 2000 meters (6500 feet).

Eastward the moraine disappears beneath a covering of old fluviatile deposits of the Karakash River. These consist of coarse

FIG. 6—Lateral and ground moraines of the "Chunak" phase in the upper Duwa Valley.

river conglomerates with a thickness exceeding 500 meters (1600 feet) overlain by sand and silt. In the lower part of the conglomeratic formation are large boulders of granitic rocks four to five meters in diameter. The conglomerate may have been derived from old morainic beds that formerly occurred outside the mouth of the Karakash Valley. The conglomerate should then represent a sediment deposited by the meltwater of a receding Karakash glacier, contemporaneous with the one that deposited the Duwa-kir moraine.

CONTRASTED TOPOGRAPHY OF THE HIGH KUNLUN

Previous to the discovery of the submontane moraines my survey of the mountain region between the lower Yurungkash and the lower Karakash valleys had revealed a very pronounced and extensive glacial morphology in the high-level regions of the mountain complex. Above the slopes of the confined, rough, and often canyon-like valleys there is found, at a level of 3000 meters (10,000 feet) and more, a landscape of quite unexpected character—an undulating grassy terrain of yellow, silty sand and loess, with scattered low, rounded hills. Though dissected with ravines plain-like remnants can generally be recognized both in summit areas and along the local watersheds. The nearer one approaches the main Kunlun divide the smaller the remnants of this old surface. Apart from the morphology, its

most characteristic feature is the complete absence of stones, boulders, or gravel, which are also remarkably scarce in the lower valleys, an interesting fact when one remembers the enormous quantities of detritus that have accumulated outside the mountains in the shape of moraines and river conglomerates.

The zone of high-level, gently undulating terrain is separated from the foreland by a zone of rough, steep mountain spurs. The

FIG. 7—Lateral and ground moraines of the "Chunak" phase in the upper Duwa Valley at an altitude of 3150 meters (10,500 feet).

boundary between mountains and foreland is very regular and distinct and has the form of a zone of fault lines (Fig. 4). At the village of Sirak, at the mouth of the Karakash Valley, one of these faults cuts the Quaternary river conglomerates; and here the displacement of the Kunlun block relative to the foreland can be estimated as at least 500 meters (1600 feet), i. e. the thickness of the conglomerates at this place. The fact that the remnants of submontane moraines are confined to the axis of a synclinal fold of Tertiary sediments makes it probable that the latest phase of the folding of the Tertiary rocks has been caused by this vertical displacement of the Kunlun block.

EXTENSION OF THE GLACIERS

Along the lower Karakash and the Duwa evidences are found of a new advance of the Kunlun glaciers, which reached the foothills of the mountains subsequent to the main tectonic movements (Fig. 5). Along the Duwa Valley lateral moraines of younger date have been traced down to the village of Chunak (Fig. 6), where they end at an altitude of about 2350 meters (7700 feet); but so far no terminal moraines of this stage have been identified with certainty, and therefore the maximum extension of the glacier during this stage is not known.

From the village of Chunak to the watershed no indication has

been found of any retreatal stages of the Duwa glacier except just below the watershed, where subrecent terminal moraines are met with in several of the tributaries of the Upper Duwa. The largest of the observed moraines is found at the head of a valley called Kichik-yailak, at an altitude of 4450 meters (14,500 feet). It consists of an arch of rough boulders and blocks some 20 meters high. It encloses a basin a kilometer long and half a kilometer broad that once was occupied by a glacier (Fig. 7). In several others of the Duwa tributaries similar glacial troughs and terminal moraines are to be seen, some empty but some of them still occupied by remnants of glaciers. Should recession continue, one more will be added to the number of dry valleys along the Kunlun.

Glacial Sediments in the Basin

The recession of the large ice streams, which occupied the valleys along the northern slope of the Kunlun during the earlier part of the Ice Age, resulted in huge quantities of meltwater that transported sediments into the Tarim basin. These glacial sediments are now accessible only at a few places outside the foothills along the southern rim of the basin. Beautiful sections occur between Karghalik and Sanju in a broad threshold of low hills and plateaus generally with anticlinal structure. Between the villages of Bora and Oitoghrak the accessible thickness of these sediments exceeds 200 meters. The lowermost horizon consists of irregularly laminated silt and sand overlain by coarse river-laid conglomerates, in turn covered by a thick formation of yellowish, fine, stratified sand of non-lacustrine origin.

The deposits of stratified sand and silt that occupy the central part of the Tarim basin are younger than the sediments just mentioned. They probably belong to the last part of the Ice Age and may have been deposited mainly by the meltwater of the Chunak stage. The lake in which these sediments accumulated covered a considerable area of the present deserts of Charchan and Taklamakan. Its western part, however, was very soon filled with sediment, while eastward open water persisted. Along the rim of the Kuruk Tagh Sai the beach line is still well preserved, and the contour of the lake can be traced in detail. It seems probable that a considerable part of the present desert of Lop was not covered with water during this period, although it now forms the deepest part of the Tarim depression.

This beach line made it possible to ascertain the magnitude of the changes of level that took place within the Tarim basin during the latest phase of the Ice Age. The level of the ancient beach line has been determined at a large number of points between the well of Suget Bulak and the ruins of Loulan partly by leveling but mainly by contemporaneous observations at two meteorological stations, which

successively moved along the beach line. The measurements showed that the beach line slopes towards the east with a considerable gradient.

As a consequence of the warping the large central lake of the Tarim basin was displaced eastwards, forming a new lake that occupied approximately the area of the present desert of Lop. It is remarkable that the mechanical sediments of this lake, such as sand and silt, are very scarce, at least in its northern part. This condition is the more striking because enormous quantities of sediments were deposited in the large central lake of the preceding stage. Possibly it may indicate that the main period of ice recession that marked the end of the Ice Age in this region had already passed by the time that warping and lake displacement took place. The remaining volume of the rivers appears not to have been sufficient to balance evaporation from the surface of the new lake. Soon its water became salty, and later on it practically disappeared. The latest phase of this evolution extends into the historical period.

Climatic Changes

Thus my work in eastern Turkestan has given definite proofs of important orographical and climatic changes in this region during and after the Ice Age. There is no doubt that during the Ice Age the glaciers of the Kunlun extended down to the Tarim basin and formed large piedmont glaciers outside the valley mouths. In the mountains of Kuruk Tagh no evidences of Quaternary glaciation are to be found, this region constituting a refuge for fauna and flora.

Between the maximum glaciation, represented by the Duwa-kir moraine, and the advance of the glaciers that reached the Kunlun foothills a very long period of less severe climate intervened. During this time the borderland of the basin was the scene of tremendous dislocations, by which it gained several new features characteristic of its present topography.

The principal phase of glacial recession in this region had passed long before the time for which written historical records are available. Yet the subrecent moraines indicate a short period of more humid climate in postglacial time. The disappearance of these glaciers necessarily resulted in a diminution in the volume of certain rivers north of the main Kunlun divide.

The investigations of travelers of many nations have given abundant proofs of a progressive desiccation of certain portions of the Tarim basin during historical time. In some cases desiccation has been caused by the rivers changing their beds, for example Loulan in the Lop desert[2] and several sites in the Muzart Darya delta south

[2] Compare the note "Lop Nor, the Wandering Lake of the Gobi," in the record section of this number of the *Geographical Review*.

of Kucha. Apart from these by far the largest number of ancient desert sites and dead forests are found along the southern rim of the Tarim basin whereas there are few along its northern rim. Several of the southern sites, for example Niya and certain sites in the Chira district east of Khotan, seem to have been deserted because of a diminution of the volume of the rivers that once supplied the irrigation water. This reduction of the water supply may have been caused by the disappearance or reduction of residual postglacial glaciers in the headwater regions. Observations in the upper Duwa Valley are in accordance with such a theory.

NOTES ON THE HUMAN GEOGRAPHY OF THE CHINESE-TIBETAN BORDERLAND*

Paul Huston Stevenson
Peiping Union Medical College

FIG. 1—A part of the mountain barrier of the Chinese-Tibetan borderland. (Photograph by Hummel.)

The Chinese-Tibetan borderland is a region unique in both its physiographical features and its human inhabitants—a wild mountainous country, aptly described by Edgar as "a mass of sawtooth peaks, precipices, box canyons, sombre forests and pounding streams,"[1] "a fascinating region presenting ethnological and other problems of great interest."[2] The height of the snow peaks projecting from the higher ranges—many of them 20,000 and at least three estimated to be over 25,000 feet high[3]—has earned for the lofty mountain complex the title of the "Himalayas of Chinese Tibet," while the beauty of the lower valleys has suggested the alternative name of the "Chinese-Tibetan Alps" or more frequently the "Szechwanese Alps." Ethnically as well as physiographically the region forms a distinct boundary between China and Tibet; politically the area has been a bone of contention between Lhasa and Peking for several centuries. An anthropological reconnaissance conducted by the author in the spring and summer of 1926 afforded an opportunity of studying both region and inhabitants.[4] The area under con-

* The author is greatly indebted to Dr. David Hummel, of Dr. Sven Hedin's Sino-Swedish Expedition to Central Asia, for kind permission to use several of his excellent photographs. Dr. Hummel's photographs were taken during a recent botanizing trip through the extreme northern portion of the Chinese-Tibetan borderland region, but those selected represent scenes thoroughly typical of the region as a whole.

[1] J. Huston Edgar: The Haunts of the Giant Panda, *Journ. West China Border Research Society*, Vol. 3, 1926–1929.

[2] Ernest Henry Wilson: A Naturalist in Western China, London, 1913.

[3] The best description of the natural features of this country is given by Joseph R. Rock in a series of admirably illustrated articles that have appeared in the *National Geographic Magazine* during the last ten years.

[4] P. H. Stevenson: The Chinese-Tibetan Borderland and Its Peoples, *Bull. Peking Soc. of Nat. Hist.*, Vol. 2, 1927–1928, Part II.

sideration is shown in Figure 2. It is from 75 to 100 miles wide and stretches along the western border of China proper from Sungpan and the Kunka Pass on the north to the still rugged though lower mountains of Yunnan some 300 miles to the south. The area as a whole is divided topographically and ethnically into several more or less distinct subregions.

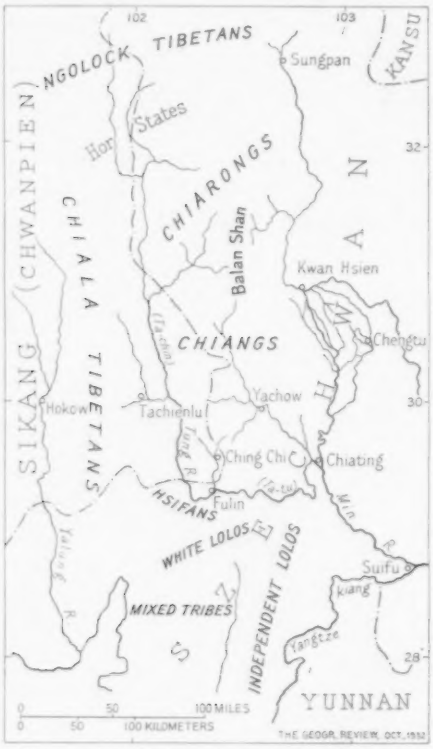


FIG. 2—Distribution of the main tribal groups occupying the central section of the Chinese-Tibetan borderland region.

Of the several entrances to the area that which is afforded by the old official Chinese road from Chengtu to Tachienlu via Yachow provides the most satisfactory cross section for the purpose in hand. This famous highway bears off to the southwest from the Chinese city of Chengtu and for four days, as traveled by chair or on horseback, traverses the small portion of the irrigated Chengtu basin that intervenes between Chengtu and the mountains on the west. At Yachow a sharp demarcation in both the topography and the type of human occupation occurs. Here the road strikes boldly into the high mountains. The irrigated rice fields and crowded Chinese cities of the Chengtu plain, exemplifying in concentrated form the outstanding characteristics of Chinese life and culture, are now left behind. From Yachow on through Tachienlu and thence to Lhasa this road earns the reputation of being the highest trade route in the world. Today little is left of its former splendor and economic importance, and only the shuffling feet of the tea carriers, their diminishing traffic being gradually taxed out of existence by tribal and brigand tolls, represent an unworthy substitute for the conquering armies and gift-bearing embassies of the past.

THE CHINESE ELEMENT

Approaching the region by this route one may consider first the presence and distribution of the few Chinese that are to be found in the area. Highly gregarious by nature, skilled tillers of the soil by

a time-honored irrigation technique, adepts at coöperative living wherein each is a social unit rather than an individual—the Chinese are ordinarily found only in those regions that enable them to indulge these specialized traits. The average Chinese represents in many ways one of the world's best examples of a thoroughly socialized individual. Even when seemingly detached from his group—either as a carrier, an itinerant trader, or an established merchant in a far distant land—the individual Chinese always maintains as close a contact with his body politic and his own kind as is possible. One of the effects of this highly developed racial and social consciousness has been to weaken the dependence of the individual upon his immediate environment as long as an economic contact with his native land is assured.

Speaking generally the relatively few Chinese found scattered through the area in question are confined to one or the other of two particular types of settlement. The more important is represented by the Chinese settlements along the great highway that for centuries has provided the link between China and Tibet. The size of the settlements and the distance between them are determined largely by the requirements of the traffic passing over the road; the smaller vary in size from half a dozen to forty or fifty families at the end of each of the various stages. At irregular intervals this number is augmented by slightly larger groups of merchants and traders that have established themselves in the few market towns along the way. Occasionally one of these larger centers will accommodate also the headquarters of a Chinese official. His task is a most difficult one. The great distance from Peking together with the difficult and dangerous nature of the duties involved combine to make official appointment to this region a matter of rather doubtful honor.

Chinese Agricultural Settlements

The second type of Chinese settlement in the region is found in the few agricultural communities that have managed to establish themselves on the occasional alluvial cones large enough to permit irrigated cultivation. The encouragement of agricultural conquest has been a definite government policy in recent years, and the old imperial title of "Warden of the Marches" is now changed to that of "Commissioner of Cultivation." The Chinese agriculturists that have taken root in this area, however, are few and far between. Preferring to starve if need be among their own kind, most of the Chinese colonists transplanted into this inhospitable region have filtered back to their former homes in the fertile lowlands of Szechwan.

Only two or three of these settlements of any size are to be found along the entire route from Yachow to Tachienlu. Each occupies an

alluvial cone or fan that projects out over the floor of one of the low and fairly wide valleys. The fans afford practically the only opportunity to be found in the region of putting into effect two age-old agricultural traditions dear to the heart of the Chinese farmer: the artificial control and distribution of the water supply and the construction of terraced fields that can be irrigated by controlling the water supply from above. Chinese civilization has from the beginning been an alluvial agricultural civilization, based on the highly developed art of small stream control. Looking down from above on one of these cultivated cones encompassing in a single field of vision the supplementary work of both nature and man engenders a train of speculations as to the possible origin and evolution of this traditional agricultural technique. Nature, it is evident, is herself busily engaged in leveling, terracing, and channeling the loose sandy soil thus deposited by water action. The natural surface of such a fan even when untouched by human hands demonstrates the relative ease with which new channels can be made, while the alternate terraces that have been formed by the recurrent freshets from above also invite the attention of a primitive agriculturist. Improvement, stabilization, and utilization of nature's crude terraces and the purposeful control of a part or the whole of the water supply by further artificial channels are only matters of time to a people alert enough to observe and profit by the object lessons thus provided for them. Some such sequence of events has probably foreshadowed the early beginnings of alluvial fan cultivation the world over.

FIG. 3—Chinese cultivated alluvial fan. Note how the fan extends all the way to the bottom of the picture. (Photograph by Hummel.)

In the case of the early Chinese the art of artificially regulating a meager though assured water supply was probably developed in Central Asia along the northern periphery of the Tibetan massif. The particular type of agricultural technique was no doubt improved

and perfected by the proto-Chinese during their slow migration eastward into the historic valleys of the Wei and Yellow rivers. Larger and more compact populations came to depend on common artificially controlled sources of water supply, thus calling into existence the elements of collective consciousness and social solidarity that even today constitute the chief basis of China's claim to superiority over the other mainland peoples of eastern Asia. The extent to which the direction and limits of expansion of subsequent generations of Chinese have been determined by this specialized agricultural technique, however, is excellently illustrated in the region under consideration. Here this particular method of cultivation, formerly the servant of Chinese advance, has now become the master. Neither in temperament, in mode of living, nor in physique are the Chinese as individuals adapted or adaptable to the type of country in question except as they are able here and there to put into practice these traditional agricultural methods. Hence the small size and scattered location of the few Chinese communities that manage to retain their precarious footing in this rugged borderland area.

FIG. 4—Chinese-Tibetan alpine valley with a typical tribal settlement. (Photograph by Hummel.)

As an actual illustration we may take the Ching Chi Valley traversed four days beyond Yachow. A diagram of a small section of this valley is shown in Figure 5. The valley in question features an alluvial fan formation low enough in altitude (6500 feet) to support a compact Chinese agricultural population and a fair-sized town. The town, Ch'ing Chi Hsien (Clear-Water Settlement) is the administrative center of a good-sized district inhabited largely by Hsifan tribes and White Lolos. Up on the mountain side just beyond the lower right-hand corner of the diagram is the site of the former Lolo capital of the region. The Black Lolos have long since withdrawn into the mountains bordering the Chien Chang Valley two days

to the south, leaving the region entirely in the hands of the Chinese. The road bearing off to the south leads down through this historic valley via Fulin and skirts the western border of Independent Lololand on its way to Yunnan. The road traversing the region from east to west is a section of the main Chinese-Tibetan highway from Yachow to Tachienlu. Figure 6 shows the east-to-west contour of the same region by a section drawn through the alluvial fan in the center and extended to include the rain screen on the east.

The Tribespeople

We turn now to the intrinsic elements of the borderland population. Beginning at a stone's throw from each side of the highway described above and occupying the narrow valleys and mountain slopes both to north and south are the so-called tribespeople, the folk that really belong to this wild mountain country. They exist for the most part as small semi-independent groups still rendering a sort of feudal allegiance to their hereditary chiefs. An extremely heterogeneous lot when considered as a whole, these people have in common a proud and defiant spirit, conscious of having successfully resisted Chinese dominion from time immemorial.

Although some of the tribal groups are apparently of Tibetan mixture, for the most part they are of obscure origins and relations. A certain amount of Chinese blood is to be detected in several of them, particularly among the White Lolos and certain of the Hsifan groups, but on the whole the tribespeoples are rather sharply marked off in physiognomy and physique as well as by social and cultural attributes from both Chinese and Tibetans. Many of the tribes represent detached remnants of larger groups that once spread widely over the more fertile lowlands now occupied by Chinese.

The outstanding groups of these mountain peoples are the various Hor States, purely Tibetan in character and occupying jointly with the Chiala Tibetan tribes the high plateau north and west of Tachienlu; the Chiarong tribespeoples, more particularly belonging to the Szechwan borderland region and dwelling in the deep valleys of the Balan Shan to the northwest of Kwanhsien; while the Ch'iangs, one of the oldest and largest of these tribal complexes, are distributed rather widely among the valleys immediately north of Yachow. To the south and west of Yachow, in an area aptly designated the "wilderness," the broader valleys are occupied chiefly by White Lolos and Hsifans; while still farther south, south of the eastern stretch of the Tung (Ta-tu) River, is the home of the Independent Lolos. Each of these major groups represents a tribal complex with numerous subdivisions into larger or smaller units.[5]

[5] Many of the details of physique, dress, dwellings, and social organizations of these peoples have been dealt with elsewhere by the author, *loc. cit.*

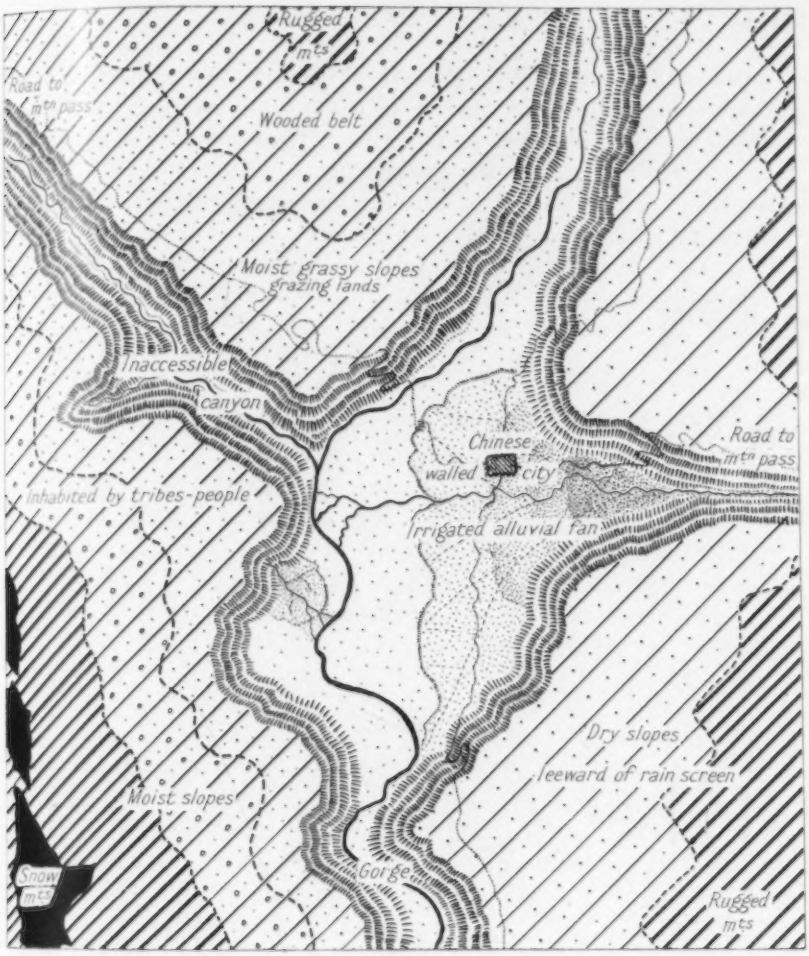


FIG. 5

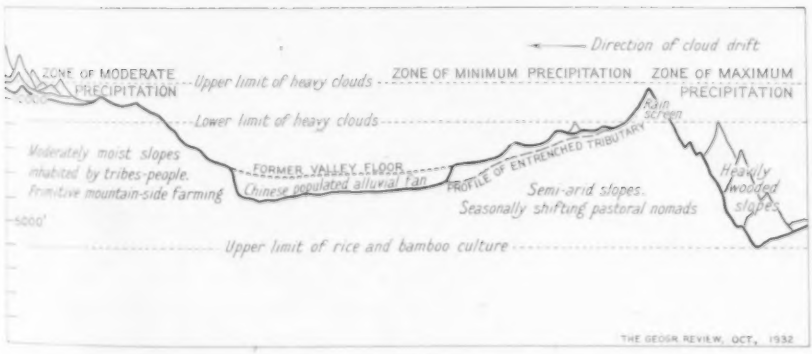

Direction of cloud drift
ZONE OF MODERATE PRECIPITATION
Upper limit of heavy clouds
ZONE OF MINIMUM PRECIPITATION
ZONE OF MAXIMUM PRECIPITATION
Lower limit of heavy clouds
Rain screen
Moderately moist slopes inhabited by tribes-people. Primitive mountain-side farming
FORMER VALLEY FLOOR
Chinese populated alluvial fan
PROFILE OF ENTRENCHED TRIBUTARY
Semi-arid slopes. Seasonally shifting pastoral nomads
Heavily wooded slopes
5000'
Upper limit of rice and bamboo culture
THE GEOGR REVIEW, OCT, 1932

FIG. 6

FIGS. 5 and 6—Regional diagram and climatic cross section of the Ching C'hi Hsien Valley.

As would be expected in the case of such a rugged and finely dissected country the inhabitants are relatively few in number and widely scattered over the region in small groups having little contact with one another and hence conserving a relatively high degree of ethnic purity. Centers of primitive ethnic types persist side by side, providing a clue in some instances to obscure ethnic strains now merged in the blended Chinese population of the present day. One such primitive strain, recognized in occasional individuals throughout the Red Basin area of Szechwan and considered by some students to have occupied a large part of central and southern China before the coming of the Chinese, is of a negrito or negroid character. In one valley, that dominated by the important center of Yunching, many excellent samples of this type are to be found. Physically the type in question is characterized by a low stature and a broad body build; a rather large head set on a short neck; eyes that show no trace of Mongolic characters; a wide-spreading and practically bridgeless nose; a marked shortening of the middle third of the face; and a rather striking maxillary prognathism with moderately thick lips. Although curly hair, and even one case of kinky hair, was noted later on among some of the Tibetan tribes farther west (Maoya-Wahsi) yet the straight black hair that appears to be dominant in Mongolian mixtures prevailed among this otherwise negroid type. It would seem, in passing, that this negroid element was probably first absorbed very largely by the earlier T'ai peoples and the resulting blend pushed southwest toward present-day Burma by the later Chinese, who evidently represented even in the beginning an already distinctive blend of more northern strains.

The Independent Lolos

Another example of the isolated survival of a distinctive ethnic type in the region under consideration is that of the Lolo. Of the two kinds of Lolos, White and Black, the latter throughout the true Lolo country constitutes a highly inbred group of relatively pure hereditary stock. Among the nobles are strict taboos against marriage outside the blood circle, and the hereditary right to the appellation of "black bones" is cherished, as Baber observes, much as in our analogous aristocratic expression "blue blood."[6] The question of the origin and ethnic relations of these Lolos is generally considered one of the most obscure puzzles of Asiatic anthropology. The outstanding physical characters of this distinctly non-oriental type are as follows: The general form of body is tall and deep-chested, conforming to the "linear" type of body build; the skin color, although

[6] E. Colborne Baber: Travels and Researches in the Interior of China, *Royal Geogr. Soc. Suppl. Papers*, Vol. 1, 1886, pp. 1–152.

usually masked by a heavy coat of tan and giving the impression of light brown, definitely suggests an underlying swarthy white rather than either a yellow or yellow-brown; the hair is straight or slightly wavy, black or dark brown in color, of finer texture than that of Chinese and frequently wound into a distinctive "horn" that projects

FIG. 7—Semi-Tibetan tribal village. Note barley field in the foreground, and racks for drying the grain. (Photograph by Hummel.)

from a little on one side of the forehead; the face is long and sharp; the long thin nose with a well developed straight or slightly aquiline profile is distinctly different from either the Chinese or Mongolian and much more finely molded than the equally straight but larger Tibetan nose; the eyes are horizontal and show no trace of a Mongolian fold; the cheek bones are rather high but small, and the long sloping jaw usually ends in a well developed round chin; the teeth are strong and even, and the lips thin and straight.

It has been suggested that the noble-blooded Black Lolos represent the remnants of the ruling cast in an aboriginal population still spread rather widely throughout southern and southwestern China. The lower classes of these aborigines are probably represented today by the White Lolos, Miaotse, Chung-Chiao (Shans), and other hybrid groups still living in large numbers in Yunnan and Kweichow. It is to be regretted that practically all the observations and the few measurements reported in connection with the unqualified term Lolo have been made upon one or other of the many groups of so-called tame or White Lolos. These, under a variety of names and with

varying degrees of mixture with Chinese blood or culture, are scattered widely over certain areas of Kweichow and Yunnan where they live more or less directly under Chinese rule. The Black Lolos of the Independent Lolo country on the other hand are without comparison the most unapproachable people of the whole Tibetan borderland. When appearing in groups in the near-by Chinese market towns, where they have mostly been observed, they display a suspicious and forbidding disposition that brooks no familiarity. They remain one of the most interesting and least-known peoples of this part of Asia.

The Problem of Lolo Origins

Although during historic and late proto-historic times at least, the prevailing ethnic movements through most of Chinese Asia have been from north to south, yet a southern or southwestern origin for the Lolo group has been repeatedly suggested. So far as the author is aware the grounds for this assumption have never been clearly stated. Certain it is that in spite of the formidable river trenches that intervene the possibility of more or less intimate ethnographic relations between southwestern China and India at certain periods cannot be lightly dismissed. Buxton in his excellent survey of the peoples of Asia, while recognizing the difficulties of any direct statements regarding this question, nevertheless lends support to the view of a southern origin of the group by accepting Jamieson's opinion that they probably came in isolated groups from Burma.[7]

It must be admitted that the Lolo somatic type approaches more nearly to that of the Indo-Afghan element recognized today in northwestern India, Kashmiria, and the Pamirs than to any of the larger ethnic groups found at present to the north of the Lolo area. But on the other hand it is even more clearly evident that certain rather significant cultural traits obtaining among the Lolos reflect a steppe experience distinctly reminiscent of Central Asia. Chief of these cultural characters are their use of felt and their intimate association with the horse. Although either or both of these are perhaps susceptible of adoption through contact only, yet they seem to be too deeply ingrained in the nature of the Black Lolos to be thus casually explained. Scanning the migration routes into this part of Asia for traces of the type, one must continue the search all the way around the northern wall of the great Tibetan massif and up into the valleys of the Pamirs bordering the extreme southwestern corner of Chinese Turkestan. The marvelous feats of horsemanship exhibited by the Pamirian mountaineers have been reported by many travelers, while both Deniker and Haddon comment upon the definite Indo-Afghan elements among an otherwise brachycephalic Pamiri (Iranian)

[7] L. H. Dudley Buxton: The Peoples of Asia, London, 1925, pp. 155–156.

population of this district. Again, these valleys lie in close relation to those of the Hindu Kush region, which, according to Haddon, constituted in times past the chief area of characterization of the Indo-Afghan type and whence, according to the same authority, they spread into North India and possibly eastwards also.

Although seemingly a long trek along the base of the Kunlun and down into western Szechwan, yet this route even today is more easily traveled than the one through the length of Hindustan and across the river trenches of Burma and offers in addition an unbroken continuity with the horse-and-felt cultural complex. Furthermore, this historic pathway has witnessed the comings and goings of a great variety of turbulent ethnic groups—Huns, Huingnu, Uigur, Yueh-chi, Scythians, Tatar, Turki, and Mongols—several of which were undoubtedly non-Mongolian in origin and character. The fertile basins and bordering mountains of Szechwan were accessible to any of these shifting ethnic elements either through the Kokonor region or through Kansu and the Kunka Pass.

This suggestion of the possibility of a northern origin of the distinctive Black Lolo is presented to prevent a too ready acceptance of the equally hypothetical view of their southern origin. All that can be said at present is that the group would appear to be of definitely non-Mongolian stock and that the somatic type bears strong resemblance to the Indo-Afghan type, which is reported to have had its center of characterization and dispersal among the mountains to the west of the Tibetan plateau.

A Stone-Age Culture

Others of the various tribal groups present problems but slightly less complex than those of the Lolos. In addition to detached physical types of interest chiefly to the physical anthropologist there are many interesting problems in cultural anthropology, philology, and primitive religions.

From the standpoint of general cultural advancement it is evident that the peoples of the region are in general just emerging from a stone-age culture. Large and small stone implements are found in considerable numbers throughout the region. These are mostly ground or polished and represent a variety of types merging gradually into the common present-day industries of the population. A remarkable collection of these stone implements, made by Mr. Edgar, the well known missionary traveler of Tachienlu, is now deposited in the Museum of the West China Union University at Chengtu. Stone mortars and pestles for pounding grain are still in common use throughout the district. Frequently these are of large size and are operated by water power. Baking on hot stones and in stone ovens is also common. A low-grade iron culture, however, is now diffusing fairly generally

throughout the area from several ore centers in the region where iron is mined and worked in primitive fashion. One very important iron-working center, Yunching, apparently supplies much of the ore and primitive manufacturing for a considerable territory. One point of interest in respect to the cultural sequence in the region is the apparent

FIG. 8

FIG. 9

FIG. 8—Typical road leading into the tribes country. The easily defendable nature of these roads is apparent. (Photograph by Hummel.)
FIG. 9—Yak transport on a high mountain-pass road. (Photograph by Hummel.)

absence of copper or bronze industries intervening between the stone and iron. This fact is all the more interesting in view of the relative accessibility of the copper mines of Yunnan through the Chien Ch'ang Valley. Although undoubtedly in contact with the early Chinese who used bronze, yet these particular tribal groups seem to have remained ethnically and culturally distinct.

SOME PRIMITIVE LANGUAGES

The Lolo language, especially its primitive pictograph, remains a study of particular interest. Phonetically this language would

appear to be an aberrant branch of the Tibeto-Burman linguistic stock; it provides, through its close relation to the ancient Si-hia (viz. extinct Tangut) language, a still further link with the north. Likewise the Ch'iang and Chiarong peoples, in respect to innumerable details of dress and architecture, to say nothing of obscure dialects

FIG. 10

FIG. 11

FIGS. 10 and 11—Tea carriers nearing Tachienlu with loads approximating three hundred pounds in weight.

and mysterious religious rites, present a rich field for general ethnological study. The general ethnological complexion of these more northern valleys suggests a Tibetan cultural veneer rather thinly covering a basic stock of more primitive and distant origins. The plundering Tibetan tribes from the northwest, using the valleys as gateways into the rich lowlands of Szechwan, formed alliances with the Ch'iangs and Chiarongs and left the impress of an early form of Tibetan Lamaism upon the country. It has been suggested that many of the pornographic elements of Lamaism have been borrowed from the ancient Bon sex worship, whose mysterious rites are still practiced in the hidden valleys of the Chiarongs. In essentials certain elements of this primi-

tive Shamanism have probably been carried over in the foundations of several of the religious systems of Asia.

Here in these mountain recesses are also to be heard the lingering tones of some of Asia's most primitive dialects, spoken daily by decreasing numbers, however, as the Chinese language and customs on the east and the Tibetan on the west are being adopted more and

FIG. 12—Stone basket bridge near Yachow. The bridge is replaced yearly after floods.

more by the younger generations. Several rather significant cultural resemblances have been noted between these Chiarong tribes and certain of the tribal groups found along the northern border of India, in Nepal, Sikkim, and Bhutan. But, as in the case of the Lolos, an adequate study of these detached ethnic remnants requires a much longer and more intimate contact than has so far been the good fortune of any anthropologist to make.

SOCIAL AND PSYCHOLOGICAL FACTORS

What has been said might seem to imply that the orientation of these tribal groups to their environment reflected simply a physical survival through retreat, but it may well be asked if certain peoples might not instinctively choose a mountain valley habitat under the urge of peculiar mental or social attributes in their make-up.

It must not be overlooked that the term "environment" in the case of the human organism embraces other than merely physical factors. Such adaptations as we find between the primitive groups under discussion and their mountain homes reflect the interplay of certain psychical and social factors involved in the situation.

Certain it is that from the standpoint of successful correlation with their environment and the application of their inherent talents to the resources at hand the efficiency of the mountain peoples must be rated exceedingly high. The average tribesman manages to exist and satisfy his basic needs in a country and under circumstances in which the average Chinese would both mentally and physically

FIG. 13—A type of rope bridge for goods and passengers in common use in the tribes country.

promptly starve to death. In the affairs of his daily life the tribesman becomes a confirmed individualist: the family and the immediate tribal group represent the extent of his sociological horizon, and each tribe is a law unto itself. This aspect of the individual's tribal distribution is a positive factor. The gregarious instinct of man is apparently by no means shared equally by all men or races. Instead of the social tendencies that draw the Chinese together a centrifugal urge seems to be operative among certain of these tribal groups, sending them into the farthest valleys to live a life of apparently preferred separation and relative solitude.

The Black Lolos, and in only a slightly less degree many of the Ch'iangs and Chiarong tribes, provide excellent examples of this deliberate withdrawal. Although they enjoy free and easy relationships within their own groups, when in contact with outsiders they almost invariably reveal a characteristically frigid and unapproachable attitude. Many of these peoples are truly immiscible elements in the ethnic complex of the region as a whole and provide material for a study of those psychical and social attributes that lie deeper and are of more fundamental importance in race relations than color of skin or form of hair.

The Hsifans

It needs to be added, however, that in many respects several of the lesser tribal groups provide rather distinctive contrasts to the Lolos, Ch'iang, and Chiarong peoples whose generalized characteristics have been treated above. Particularly is this true of the Hsifan and White Lolo groups. Under the loose title of "Hsifan," which is a Chinese term meaning merely "western Barbarians," are included a large number of unrelated non-Chinese peoples scattered widely throughout the hinterland areas of China proper. In western Yunnan the term applies to a group of hybrid peoples of predominantly Tibetan mixture.

The Hsifans of the Tung River section of the borderland on the other hand, interspersed between the White Lolos of the wilderness on the north and the Black Lolos of Independent Lololand on the south, show no trace of Tibetan blood or culture. These peoples are cultivators of the lower slopes and in addition expert fishermen. Physically they are small in stature and possess whiter skins and rosier complexions than any of the other groups met in the region. Their facial features are rather delicate and regular, lacking the sharpness of the Lolos on the one hand and the coarseness of the Tibetans on the other. These Hsifans show little of the aloofness that characterizes their neighbors and reveal a distinct disposition to adopt Chinese culture. They are in contact with this superior cultural complex at Fulin, a good-sized Chinese center on the Tung River at the head of the lateral Chien Ch'ang Valley, where an important Chinese commercial highway bears off to the south past the Independent Lolo country and on into Yunnan.

The process of gradual adoption of Chinese culture among these Hsifans, with the ultimate result of their final absorption into the Chinese cultural group, is of interest as illustrating a process that has been going on along the southern and western periphery of the Chinese peoples for several centuries. One of the first steps of this cultural invasion is the wearing of Chinese dress among the men, while here and there are individuals having the added distinction of being able to speak the Chinese language and perhaps even being able to read the Chinese written characters. The sons of the chiefs and other well-to-do families are frequently sent to Chinese schools in Fulin or Yachow or even on to Chiating or Chengtu. On returning to their homes these highly traveled young men like to associate with the Chinese residents of the region and often speak of themselves as "we Chinese." In the imitation of the Chinese by these Hsifan groups we are witnessing nothing less than one of the most basic of the various factors underlying the whole phenomenon of human progress. Here two disparate cultures are in contact. One of them is consciously striving

to imitate the other on account of the prestige accruing therefrom to the imitator. As has probably always been true since the earliest beginnings of human progress, the single factor most conspicuous as providing that precious element of prestige is that of economic superiority. Such non-material cultural elements as beliefs, attitudes, and social practices may follow after, but it is doubtful whether these ever come first, in spite of the naïve belief of many that they invariably form the vanguard of human progress. In certain cases the people of whole settlements of Hsifans, perhaps without a drop of Chinese blood in their veins, have come to consider themselves as true Chinese.

"Chinese" a Cultural Term

The term "Chinese," therefore, as applied to certain areas of China must be considered as a purely cultural rather than a racial term. In this connection it cannot be doubted that much of the apparent Chinese racial displacement of the greater part of the T'ai population formerly occupying most of the region south of the Yangtze is in fact a cultural displacement only. The typical Cantonese of today is most probably still a Shan in blood and basic temperamental disposition, although he has long since adopted as his own the vastly richer cultural complex evolved by the sons of Han. Be that as it may, many of the Hsifan groups occupying the lower and more open valleys of the borderland region provide excellent examples of the various stages by which the absorption of non-Chinese racial elements into the general Chinese cultural complex takes place. They also illustrate in their particular environmental situation and psychical make-up some of the factors that permit such an amalgamation. It remains to be noted that, whereas the more mobile masculine element has in many instances traveled far along the road to becoming "Chinese," this progress is much less true of the women.

Tachienlu

As one turns away from the rushing Tung River at Wassukow for the last leg of the climb to Tachienlu one usually looks up the river, here known as the Ta Chin (Great Gold) River, toward the Badi-Bawang tribes' country to the north. The accounts of the Emperor Chien-Lung's efforts to extend Chinese control over this lucrative area record some of the most difficult military expeditions of that famous Emperor's long reign (1736–1796).

Close by on the east is the equally unique Mupin region,[8] a particularly wild area of special interest from zoölogical and botanical as well as ethnological standpoints. Living in these valleys for instance

[8] J. H. Edgar: Muping, the Land of the Giant Panda, *China Journ. of Sci. and Arts*, Vol. 5, 1926, pp. 183–184.

is that mysterious animal the Giant Panda, lately hunted here under most difficult conditions by the Roosevelt brothers.[9]

Turning sharply to the west the traveler has before him the most fascinating and arduous day's climb of the whole ascent from Yachow to Tachienlu. The net rise encountered in the remaining twenty miles is only 3000 feet, but the up-and-down contortions of the narrow footpath add fully as many feet again to the climbing necessary to accomplish this last stretch, while down through the gorge a glacier-fed stream formed above by the junction of two good-sized tributaries at Tachienlu makes one of the wildest and most prolonged plunges to be seen anywhere.

Tachienlu, familiarly known as the Shanghai of Tibet, constitutes the gateway into the best climated and most populous province of Tibet—namely the eastern province of Kham. The city is the former capital of a semi-independent Tibetan state, the Kingdom of Chiala, whose territory extended for several days' journey to the north, west, and south. This petty kingdom was maintained as an administrative area under the subordinate rule of the King of Chiala until the days of the Chinese Republic. A true border-town atmosphere pervades the place, reflecting sharp contrasts in inhabitants, topography, and mode of travel. Here the endless chain of human carriers from the lowlands of China dumps its bales of tea, cloth, tobacco, spices, needles, building materials, oil, and other items of the outside world and loads for the downward trip with sheep's wool, fox skins and a variety of other hides, yak tails, musk, deer horns, rhubarb, and occasionally rugs and other articles from Kashmir or other regions even farther to the west. At Tachienlu the long caravans from Lhasa converge by two routes. The yak are quickly unloaded and sent up into the higher pastures to graze and wait for the return journey, for the city itself is only a little over 8000 feet high and is unsuitable for these beasts of the high plateau. The small settled population of the town is far outnumbered by the large floating population of transient merchants, traders, officials, and caravan men, among whom the Tibetans usually outnumber the Chinese about two to one.

[9] Theodore Roosevelt and Kermit Roosevelt: Trailing the Giant Panda, New York and London, 1929.

THE RISE OF CIVILIZATION IN CHINA WITH REFERENCE TO ITS GEOGRAPHICAL ASPECTS*

C. W. Bishop

THROUGHOUT the historical period the centers of civilization in the West have been moving ever farther away from the equator. But in China the advance has been in the reverse direction. There alone in antiquity a high civilization arose in a region of really cold winters, the basin of the Hwang Ho, and spread thence over the warmer lands to the south.

In the diffusion of culture the lay of the land has played a prime part. Generally speaking, China proper has a rugged relief, only about ten per cent of its surface, mainly in the north, being occupied by plains. In primeval times unbroken forest united the Yangtze basin with the Himalayan and Indo-Chinese regions, while the faunal evidence shows that continuous strips of woodland must have extended across northern China right up to Manchuria.[1] The loess soil, however, filling the valleys of the northwestern uplands and extending far eastward across the "Great Plain"[2] discouraged a heavy tree growth; hence these areas, like similar ones in Central Europe and elsewhere, included great tracts of open grassland. A fact of preëminent significance to the cultural advancement of ancient China was the existence of a Eurasian steppe zone opposing no transverse barriers to the free eastward flow of stimuli from the far older culture lands of the West. Likewise important was the presence in northern China of a fertile and comparatively open lowland region of temperate climate, well fitted to become the seat of a high civilization.

The Earliest Chinese

Thus far no sign in China proper of any early phases of the New Stone Age has been found. They may possibly come to light in the course of further archeological research. On the other hand, it is perhaps more likely that the proto-Chinese had already passed through these stages elsewhere. Ethnologists seem agreed that the Mongoloid

*In this paper have been embodied the more important conclusions regarding cultural diffusion in southeastern Asia that have been reached since "The Geographical Factor in the Development of Chinese Civilization" appeared a decade ago in the *Geographical Review* (Vol. 12, 1922, pp. 19–41).

[1] Regarding the former existence of wooded areas in northern China see A. de C. Sowerby: The Natural History of China, *Journ. North-China Branch of the Royal Asiatic Soc.*, Vol. 53, 1922, pp. 1–20; specifically p. 3; also *idem*, A Naturalist's Note-Book in China, Shanghai, 1925, pp. 12 *et seq.*

[2] On the extent of the loess in northern China see V. K. Ting: Prof. Granet's "La Civilisation Chinoise," *Chinese Soc. and Polit. Sci. Rev.*, Vol. 15, 1931, pp. 265–290, specifically p. 268.

or Xanthoderm branch of the human family was specialized in Inner Asia. That region—after a last period of intense cold had given place to warmer conditions—became and long remained genial parkland and meadow, with lakes and streams fed by the melting glaciers of the neighboring mountains. Such an environment was favorable for human progress, and in Mongolia evidence has been found of development from a purely hunting and fishing and food-gathering economy into a cultural stage that practiced the rudiments of planting.[3]

It was apparently after some at least of the Mongoloid stocks had achieved this degree of progress that slow desiccation of their homeland started them drifting southward into moister regions. The movement thus inaugurated carried them over most of southeastern Asia. The earliest of these peoples yet known who can in any sense be called Chinese are found already in possession of a fairly advanced Neolithic culture. In the valley of the Hwang Ho its remains occur perhaps more abundantly in the loess but are widely distributed in the alluvium as well.

These proto-Chinese of the north[4] probably had a social organization based on matrilinear descent. How far they had developed the institution of chieftainship, either male or female, is uncertain. They were not pastoral nomads but sedentary planters, practicing a milpa type of cultivation with the aid of stone-bladed hoes. Millet seems to have been their only cereal, while their domestic animals were the dog, the pig, and possibly the fowl. Clothing they made from skins, bark cloth, and perhaps hemp; and they used a coarse pottery, shaped by hand. During the long cold winters they lived in villages of beehive-shaped earth lodges partly excavated in the ground, while in summer they appear to have occupied huts raised on stilts near their cultivated patches. Religion was animistic and orgiastic, with fertility rites which included human sacrifice and perhaps ceremonial cannibalism.

Distinct but allied cultures, associated with certain ethnic differences, existed in the more rugged and densely wooded south. There communal pile dwellings were in use; and, owing largely to the more mature character of the river systems, canoe navigation attained a greater development than it did in the Hwang Ho region. These and other local specializations were in part the result of climatic and physiographical differences. Broadly speaking, however, all the New Stone Age cultures of southeastern Asia were fundamentally of the same type.

[3] Regarding this development see N. C. Nelson: The Dune Dwellers of the Gobi, *Natural History*, Vol. 26, 1926, pp. 246–251, specifically p. 251; also *idem*, Archaeological Research in North China, *Amer. Anthropologist*, Vol. 29, 1927, pp. 177–201, specifically p. 197.

[4] On the essential similarity of the Neolithic populations of northern China to the present-day inhabitants of that region see Davidson Black: The Human Skeletal Remains from the Sha Kuo T'un Cave Deposit in Comparison with Those from Yang Shao Tsun and with Recent North China Skeletal Material, *Palaeontol. Sinica*, Ser. D, Vol. 1, fasc. 3, Peking, 1925, pp. 1–120, specifically p. 98.

The communities of Neolithic Chinese peasants, like those of people everywhere at a similar cultural stage, seem to have been largely self-sustaining. The rarity on their village sites of objects or materials foreign to the locality indicates that trade was undeveloped, while the scarcity of weapons suggests that there was little warfare. But supplies of workable stone for the manufacture of tools, as important to Neolithic man as deposits of metal are to us, were wholly lacking in the alluvium and hardly less so in the loess. They had to be sought in rugged and densely wooded regions which would otherwise have offered slight inducement to penetration. Some of the stone implements found on prehistoric Chinese village sites must have been brought there, whether in their finished state or in the shape of raw material, from very considerable distances.

Natural Deficiencies of Southeastern Asia

A culture of this type, especially in a region like southeastern Asia naturally deficient in wild animals and seed-bearing grasses susceptible of domestication, could scarcely of itself have developed into a high civilization. This point should be stressed, for it has been much neglected. Most if not all domestic animals and cereals that form the economic basis of present-day Chinese life are demonstrably of foreign origin, and many of them were not introduced until after the beginning of the Chinese historical period. Wherever the aboriginal inhabitants of China have achieved any marked progress in historical times it has been without exception through culture borrowing. The groups that live today in various isolated districts have signally failed to advance themselves through their own efforts. The truth seems to be that the Late Stone Age peoples of the southeast of Asia, including the proto-Chinese, had developed a culture pattern too rigid and inelastic to permit of progress beyond a certain point. This pattern had adjusted itself closely to its environment; but in so doing it had hardened into a routine from which escape was possible only through the aid of external stimuli. Such a cultural phenomenon has occurred time after time in the world's history. It is being repeated today in China itself on an unprecedented scale.

The requisite impetus from without was provided by two streams of influence. One of these flowed from Indian regions, the other through Central Asia but from ultimate sources in lands farther west. The two currents met and mingled in the Yangtze basin, with interpenetrations in both directions.

Cultural Migrations from the South

The more important of the Indian culture elements entered China, so far as can be told at present, during and perhaps before

the second millennium before the Christian era. The course they followed was from northeastern India, across the upper basin of the Irrawaddy, and so into the central and northern portions of the western Chinese province of Yünnan.[5] They thus reached the

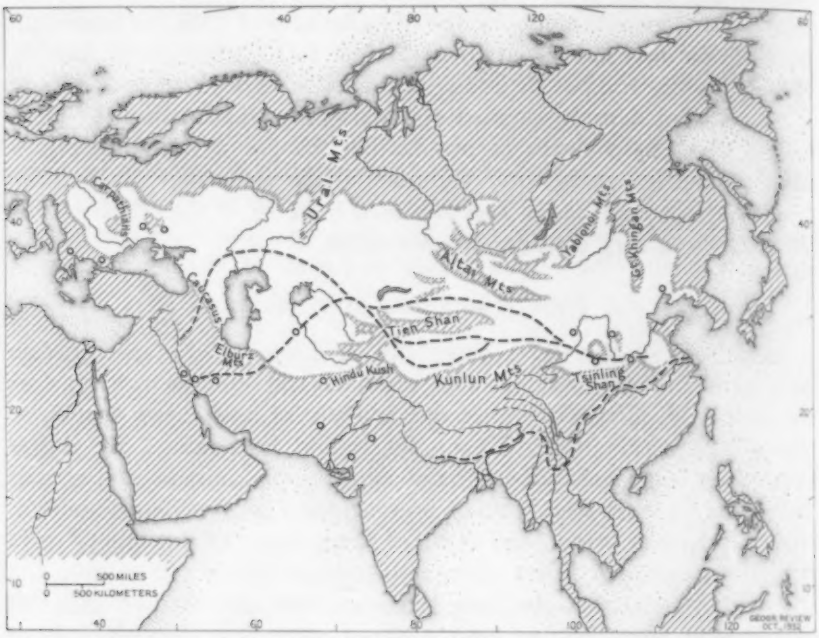


FIG. 1—The northern steppe belt of the Old World (unshaded). Routes of cultural migration to China are shown by dashed lines; regions where painted pottery has been found are marked by a small circle. Scale of map approximately 1:90,000,000.

Yangtze; then worked their way down that stream, creeping laterally up its tributaries the while, until by this roundabout route they eventually arrived at the coast. It may be remarked that within the past two or three centuries maize, a plant of American origin, has entered China from India by this same route, whose importance in the cultural history of southeastern Asia has scarcely been appreciated. The extremely rugged and forest-clad hill country of southwestern China formed a barrier to more direct penetration, as it still does in large part.

It is possible that millet and also "dry" or upland rice, the former at least grown from very early times, may have entered China in this way, for neither of them seems indigenous there, while on the other hand there is some reason to believe that both are natives of India. But of all the latter's gifts to China by far the most important was

[5] Burma and Yünnan form a geographical unit. See C. W. Bishop: The Geographical Factor in the Development of Chinese Civilization, *Geogr. Rev.*, Vol. 12, 1922, pp. 19–41, specifically pp. 23 and 26.

"wet" or irrigated rice. The cultivation of this plant appears to have begun in some region near the head of the Bay of Bengal.[6] Thence it spread both west and east. Peculiarly suited to monsoon regions, it became in time the dominant crop in much of central and southern China and even extended itself into parts of the north.

The fowl, first domesticated in Upper Burma or thereabouts, must have penetrated China by the same route; but being less subject to climatic limitations it spread much farther north than did the growing of irrigated rice. It is uncertain as yet whether fowls were kept in China during the Neolithic period, although it is likely. They had at all events become perfectly well known in the basin of the Hwang Ho by the latter part of the second millennium before the Christian era, when the Chinese Bronze Age had already begun.

China seems also to have owed to India the water buffalo, or carabao, as well as that zebu strain in her domestic cattle especially noticeable in the southwest and south. The practice of taming elephants, once so abundant in most parts of China,[7] may have been borrowed from the same source. It is by no means impossible, too, that from India some knowledge of metals reached the Yangtze Valley.

These and other Indian influences profoundly modified the economic life of southern and central China. They had comparatively little direct effect on the growth of civilization in the valley of the Yellow River, for many of them were unsuited to the drier and colder climate of that area.

The Northern Cultural Route

Quite different in character were the culture traits that at various times reached northern China through Central Asia. For not only had they been originally evolved in cooler and less humid regions than those coming from India; but many of them, particularly those pertaining to social and political organization, were of a nature not affected by climatic conditions. Hence they became the principal factors in the shaping of the historical Chinese civilization, and their influence gradually pervaded almost the entire country.

The manner in which these cultural migrations across Inner Asia took place and the extent to which they were accompanied by actual ethnic movements are questions still awaiting definite answer. The more important of them had already occurred before the dawn of

[6] On the origin of irrigated rice culture see E. B. Havell: The History of Aryan Rule in India from the Earliest Times to the Death of Akbar, New York, 1918, p. 15; also S. V. Mosseri: Sur l'origine du riz et l'histoire de sa culture en Égypte, *Bull. l'Union Agricole d'Égypte*, Vol. 20, 1922, pp. 5–15. Attempts to show on botanical grounds that irrigated rice culture must have begun in the East Indian Archipelago ignore the historical and ethnological evidence.

[7] Regarding the former existence of elephants in China see C. W. Bishop: The Elephant and Its Ivory in Ancient China, *Journ. Amer. Oriental Soc.*, Vol. 41, 1921, pp. 290–306.

history in China, and there is in consequence no written record of their arrival in that country.[8] Individual culture traits were transmitted in the usual way, through contacts, peaceful or hostile, between intervening peoples. In certain cases, however, organized invasions, followed by conquest and settlement, undoubtedly took place. These have occurred time after time during the historical period, and there is every reason to believe that they did so in prehistoric times as well.

Movements in the Grasslands

The Eurasian steppe zone has been traversed over and over again in all ages by both faunal and human migrations.[9] Its chief routes cross Dzungaria, between the Altai and the Tien Shan mountain systems, while others pass through the Tarim basin, north of the Kunlun Range. The primary causes of the migrations of various kinds which have repeatedly flowed along this great natural thoroughfare have undoubtedly been climatic.[10] Periods of humidity, bringing about an increase in numbers of both man and beast, have alternated with others of drought that led to general turmoil and unrest. The movements thus set up profoundly affected the western portions of the ancient world. More pertinent to our inquiry is the fact that, allowing time for their influence to travel across Inner Asia, they synchronize strikingly with certain important developments in northern China.

The intervals between these epochs of disturbance in the West and the corresponding events in the Yellow River valley grew steadily shorter, a fact pointing to the operation of accelerating causes. One of these, perhaps the most important of all, was the increasingly effective utilization of the horse by the peoples of the western grasslands. It was probably during the latter half of the third millennium before the Christian era that they began to yoke that animal to the chariot,[11] thus devising the most efficient instrument of predatory war that had so far been invented by man. During the next thousand

[8] For an appraisal of our written sources for early Chinese history see L. C. Goodrich: The Canonical Books as Source Material, *Chinese Student Bulletin* (Columbia University, New York), Vol. 2, 1928, p. 3; Henri Maspero: La Chine antique, Paris, 1927, Introduction, pp. xii *et seq.* Also Bernhard Karlgren: The authenticity of Ancient Chinese Texts, *Museum of Far Eastern Antiquities (Ostasiatiska Samlingarna) Bull. No. 1*, Stockholm, 1929, pp. 165–183. It is only fair to say that the last word on this subject is still very far from having been said.

[9] A historically recent example of such a migration was the flight of the Torguts from the Volga region to the province of Ili in 1771. Regarding these routes across Eurasia see A. M. Berthelot: L'Asie ancienne central et sud-orientale d'après Ptolémée, Paris, 1930, Ch. 2, La route du nord, pp. 34 *et seq.*

[10] On the connection between climatic fluctuations and ethnic movements in Inner Asia see Ellsworth Huntington: The Pulse of Asia, Boston and New York, 1907, *passim;* also J. C. Curry: Climate and Migrations, *Antiquity*, Vol. 2, 1928, pp. 292–307; also Owen Lattimore: Caravan Routes of Inner Asia, *Geogr. Journ.*, Vol. 72, 1928, pp. 497–531, *passim*, and especially pp. 519 *et seq.*

[11] Regarding the effects of the utilization of the horse see Harold Peake and H. J. Fleure: The Steppe and the Sown, New Haven, 1928, *passim;* also V. Gordon Childe: The Aryans: A Study of Indo-European Origins, London, 1926, Index, *s. v.* Horse; also The Cambridge Ancient History, Vol. 1, New York, 1923, p. 107; also Berthelot, *op. cit.*, pp. 18 *et seq.*

TABLE I—PARALLELISM OF EVENTS WEST AND EAST

OCCIDENT	CHINA
Bronze weapons and chariots drawn by asses used in Mesopotamia and perhaps on the Iranian plateau, before 3000 B.C.	Neolithic Period.
Era of turmoil in western steppe region begins *ca.* 2700 B.C.	
Overthrow of Dynasty of Agade in Mesopotamia *ca.* 2570 B.C.	Appearance in Hwang Ho basin of painted pottery made on wheel *ca.* 2500 B.C.?
Fall of Old Kingdom in Egypt *ca.* 2450 B.C.?	Use of copper begins in extreme northwestern China *ca.* 2100 B.C.?
Western steppe people acquire from their southern neighbors use of bronze and chariots, and yoke horses to latter, before 2000 B.C.	Legendary Hsia Dynasty founded *ca.* 1800 B.C.? Bronze Age civilization perhaps introduced into China then.
Horse known in Mesopotamia by 2000 B.C.	
Unrest in western steppes *ca.* 1800 B.C.	
Kassites introduce horse-drawn chariot into Mesopotamia *ca.* 1760 B.C.	
Hyksos introduce both horse and chariot into Egypt about this time.	Semi-historical Shang Dynasty founded *ca.* 1500 B.C. High Bronze Age civilization, with chariots and writing, in northern China.
Chariot-using Vedic Indians invade Punjab during same period.	
Renewed turmoil in steppe zone *ca.* 1200 B.C.	
Use of mounted troops and of iron weapons begins about this time.	Historical Chou Dynasty founded by invaders from west *ca.* 1050 B.C. Use of bronze weapons and chariots continues.
Disturbances in West *ca.* 800 B.C.	
Horse-riding invaders from the steppes appear in eastern Europe and southwestern Asia.	Chou Dynasty driven eastward by attack from west 770 B.C.
	Use of iron and of mounted troops begins in China *ca.* 500 B.C.

years or so the horse-drawn chariot spread into almost every part of the eastern hemisphere north of the equator where conditions permitted its use, from western Europe and northern Africa to northwestern India, central Siberia, and northern China. It appeared latest and survived longest at the two extremities of the Eurasiatic continent, in those regions most remote from its original center of distribution. The process of its diffusion affords one of the master clues to the history of ethnic movement in the ancient world.[12]

The parallelism of events in the West and in China is shown in the table on the preceding page, an expansion of that presented earlier by the writer.[13]

Painted Pottery as Evidence of Relations with the West

During the Neolithic period types of hand-shaped earthenware were used in all parts of the country, north and south alike. But associated with them in a particular region there has been discovered a fine polychrome painted ware, in part at least turned on the wheel and displaying in other respects also very different and far more highly specialized characters.[14] The mere presence of such a superior ware would in itself lead us to suspect cultural infiltration if not actual ethnic intrusion. Other circumstances strengthen this probability. The painted ware has so far been found only in the upper and middle portions of the Hwang Ho Valley and its vicinity, the very section of China most open in ancient times to invasion by cultural elements from the west. Moreover, the undeniable resemblances existing between this ware and certain Occidental ceramic types become more marked farther west in the area where it has been found. Of an independent origin of painted pottery in China no indication has so far come to light; it seems rather to have been already fairly well developed when it first appeared there. The use of some form of the potter's wheel in its manufacture is also significant; for that instrument was known in the more advanced parts of the Occident far earlier than it was in China. It is to be remarked that one of the known consequences of the disturbances that agitated the grasslands in the third millennium before the Christian era was the dispersal of the painted pottery makers of the Occident far and wide.[15]

[12] On this see C. W. Bishop: Man from the Farthest Past (Smithsonian Sci. Ser., Vol. 7), New York, 1930, pp. 285–289 and *passim*.

[13] Bishop, The Geographical Factor in the Development of Chinese Civilization, p. 31. The dates there assigned for the beginning of the three earliest Chinese dynasties were calculated retrospectively from the first century of the Christian era and are without precise historical significance.

[14] An interesting series of papers on the painted pottery culture of prehistoric China is to be found in the *Palaeontologia Sinica*, Ser. D, Vol. 1, Peking, 1923–1925; see also J. G. Andersson: An Early Chinese Culture, *Bull. Geol. Survey of China, No. 5*, Peking, 1923; also Davidson Black: A Note on the Physical Characters of the Prehistoric Kansu Race, *Memoirs Geol. Survey of China*, Ser. A, No. 5, Peking, 1925, pp. 52–56.

[15] See Peake and Fleure, *op. cit.*, pp. 41 *et seq.*; also The Cambridge Ancient History, *loc. cit.*

The Bronze Age in China

That distinctive phase of material culture commonly known as the Bronze Age in marked contrast to the ages of Stone and Iron was far from being a world-wide phenomenon. On the contrary it occurred only in a relatively small but continuous portion of the earth's surface corresponding roughly to the North Temperate Zone of the Old World.[16] In southwestern Asia it had already begun by 4000 B.C., and it lasted until about 1000 B.C. or slightly longer. In northern China it did not begin until much later, most probably some time after 2000 B.C., but continued nearly down to the opening of the Christian era. The attention of students has frequently been drawn by its fundamentally similar character in both these regions.[17] In the West the Bronze Age has been traced by archeologists through several successive periods of evolution. In China no trace of the earlier of these has been found; on the contrary bronze working appears there quite abruptly as an already matured art. It does so, moreover, not as an isolated phenomenon but as an integral element of a whole well-knit culture complex whose individual traits occur centuries and in some cases millenniums earlier in the Occident than they do in China. These circumstances taken together can only be explained as indicating repeated eastward migrations along the steppe zone during the Bronze Age, certainly of cultures and in some instances of peoples.

There was of course no mass transference of either from the banks of the Euphrates and Tigris, or even of the Oxus and Jaxartes, direct to those of the Hwang Ho. The process, like all great human movements, was long and complicated and is only beginning to be grasped in part. What must have happened was something like this. Certain culture traits, including the knowledge of bronze working and the use of wheeled vehicles, spread from southwestern Asia before the close of the third millennium before the Christian era to the grasslands north of the Caucasus, the Elburz, and the Hindu Kush. There they underwent local modification and were then still further disseminated in various directions, among them to the river basins of northern China. There they were able to take root and develop along specialized lines under the influence of a new and favorable environment.

The civilization which thus arose in the valleys of the Yellow River and its chief affluents comprised many features quite alien to the aboriginal Neolithic culture. Among these were the knowledge of bronze, the organization of society on a rigidly patriarchal basis,

[16] Bronze was being used to some extent in Peru at the time of the Spanish Conquest; but that historical fact by no means justifies us in ascribing to the Incas a true Bronze Age civilization comparable to the one that had come to an end in the Old World something like two thousand years before.

[17] On the cultural similarities between China and the West see Berthold Laufer: Some Fundamental Ideas of Chinese Culture, *Journ. of Race Devel.*, Vol. 5, 1914–1915, pp. 160–174.

and the habit of living in groups of wooden houses forming quadrangular towns defended by ramparts of tamped earth. Horses, cattle, sheep, and goats, all natives of the West, now appeared. Wheat and other cereals indigenous to the same region were cultivated. Wheeled vehicles, including the horse-drawn chariot and the oxcart, were introduced.[18] It is noteworthy that the archaic Chinese attached animals to vehicles but not, apparently, to the plow; for it is just the former that have been used by peoples on the march, while the latter has accompanied the slow diffusion of agriculture. The ox-drawn plow eventually appeared in China but, as recent investigations on the part of Chinese scholars seem fairly to have demonstrated, considerably later than the other traits just named.

FIG. 2—Map showing the cradle of the Chinese Bronze Age civilization (stippled area): its northeastward extension is quite uncertain. Numbers have reference: 1, seat of the legendary Hsia Dynasty; 2, final seat of the Shang Dynasty; 3, earlier capital of the Chou Dynasty; 4, later capital of the Chou Dynasty. Scale of map 1:37,000,000.

BEGINNINGS OF STATE BUILDING

This Bronze Age type of civilization did not at once supplant the old Neolithic culture of northern China. On the contrary it was confined for a very long period to the warlike ruling class of numerous small autonomous city states, dotted about like islands in a wide sea of New Stone Age barbarism.[19] The location of these states was determined by geographical considerations. In the rugged northwest they were situated in river basins like those of the Wei in Shensi and the Fên in Shansi, both draining into the middle Hwang Ho and both very early culture centers. In the Great Plain, areas were sought that were protected by natural frontiers of river and marsh

[18] The Chinese character for "army" contains that for "chariot" as one of the elements. Early forms of the latter ideograph show that at first cars were drawn by two horses; later on in the Chinese Bronze Age teams of four animals, yoked abreast, were used.

[19] These city states are spoken of, retrospectively, in the ancient Chinese writings as "ten thousand" in number, but the word used has here its alternative meaning of "myriad."

and were well watered without being exposed to inundation. The aims were similar in all cases: defense against other states and against the enveloping aboriginal populations; possession of as much arable land as possible; and control of trade routes, so vital to the maintenance of a Bronze Age civilization.[20]

Towns were frequently built on these lines of communication, especially where two or more of them intersected. In piedmont regions they often grew up near points where passes across mountain ranges debouched upon the lowlands. Again, wherever higher relief afforded immunity from floods they were situated close to streams and particularly in their forks. On the plains, owing to the recurrent inundations, there could be little permanent settlement near the rivers.

It was probably in connection with this superposing of a Bronze Age civilization upon the antecedent Late Stone Age culture that a sharply marked social division arose into a privileged and an unprivileged class.

At the head of every city state there seems to have been a hereditary priest chieftain claiming divine or superhuman descent, one of whose principal functions was to conduct the worship of the supreme deity, the Sky God. The nobles from their fortified towns wielded seigniorial authority over the surrounding districts. They delighted in battle and hunting, both conducted in chariots as in the contemporary West. The breeding of horses and cattle was one of their chief concerns. They worshiped the spirits of their ancestors with elaborate rites. After death their bodies, covered with red pigment and accompanied by those of attendants, male and female, and by much treasure, were interred in wooden chambers under barrows or grave mounds, counterparts of the *kurgans* of the steppe region.

A class of rural serfs who dwelt apart in their own village communities formed the bulk of the population. Down to a late period these retained their old Neolithic culture, doubtless considerably truncated and impoverished.[21] They were greatly oppressed by their feudal lords with heavy imposts and *corvées*, rigorously exacted. It was they who tilled the soil, apparently with foot plows[22] and mattocks shod with stone; for bronze never became cheap enough to be generally used for agricultural implements.

This command of large bodies of forced labor made possible the undertaking of the work of development that in the long run transformed China into the land of intensive cultivation it is today. The

[20] On trade during the Bronze Age see V. Gordon Childe: The Bronze Age, New York, 1930, pp. 7 *et seq.*

[21] The manufacture of painted pottery, for example, apparently died out about the beginning of the Chinese Bronze Age, while the old coarse Neolithic ware long continued to be made. The pottery of the nobility seems to have been very different from either.

[22] Foot plows are still used in some parts of China and are identical in principle with the *caschrom*, for example, used until recently in northwestern Scotland. See E. Cecil Curwen: Prehistoric Agriculture in Britain, *Antiquity*, Vol. 1, 1927, pp. 261–289.

accomplishment of this task required much more than local and desultory effort. The imperative need especially for unifying and coördinating water control over wide tracts of country contributed powerfully to the eventual formation of larger territorial units under a single authority. Exactly the same thing had happened something like two thousand years earlier in Mesopotamia.

The ancient Chinese nobles were able to maintain themselves over their own peasants and against the barbarian communities around them largely through the possession of superior weapons. In earlier times their principal offensive arms, beside the compound bow, were the socketed spear and the dagger ax or "halberd," both of bronze; while for defense they used hide armor and shields of wood or leather. The bronze sword was late in appearing in China; perhaps it did not appear until around the beginning of the first millennium before the Christian era or even later.[23] The type mainly used there was a short double-edged stabbing blade of unmistakable Scythic affinities;[24] it never acquired the "leaf shape" so characteristic of the latest bronze swords of the Occident. Chinese bronze weapons in general display features belonging to various epochs and different culture areas in the West. A complete and detailed analysis of these will some day throw much light on the subject of Chinese origins.

Bronze was likewise employed for the fabrication of numerous classes of objects beside weapons, making all told great demand for the constituent metals of the alloy. But copper and tin, particularly tin, are scarce or entirely wanting in most parts of northern China and had to be procured from a distance through trade or conquest.

The Quest for Metals

Copper may have been found in more regions than one; for deposits of that metal are somewhat widely distributed. During the early historical period it seems to have been imported mainly from the hilly and well mineralized regions of the south. The ancient book the *Yü Kung*, or "Tribute of Yü," dating back at least to the closing period of the Chinese Bronze Age, names the Yangtze basin alone as the source from which copper was obtained. The demand for it undoubtedly played an important part in the relations, both warlike and commercial, between the ancient Yellow River states and that area.

Analyses of Chinese bronze objects suggest that the amounts of tin available to the metal workers of the Hwang Ho Valley in

[23] Regarding this point see Olov Janse: Notes sur quelques épées anciennes trouvées en Chine, *Museum of Far Eastern Antiquities* (*Ostasiatiska Samlingarna*) *Bull. No. 2*, Stockholm, 1930, pp. 67–134, specifically p. 93.

[24] For the affinities of the ancient Chinese bronze sword consult The Cambridge Ancient History, Vol. 3, New York, 1925, p. 198; also *ibid.*, Vol. 1 of Plates, New York, 1927, p. 256 and plate opposite.

antiquity were fluctuating and irregular.[25] That metal is far less generally distributed than copper. The deposits that occur in Khorasan, in the Malay Peninsula, and even in Burma and Yünnan would all seem too remote to have been accessible to the civilized peoples of northern China during their Bronze Age. It is still a mystery whence they procured their tin. We can only be sure that it came from some region outside the Great Plain.

Extension of Trade and Trade Routes

A Bronze Age civilization anywhere presupposes a considerable organization and wide extension of trade. That of China was no exception. To the ancient aristocracies of the Yellow River states the lands to the south were a region of fabulous wealth. Among the riches to be obtained from the Yangtze Valley were slaves, gold, silver, copper, hides for armor, yak tails for standards, ivory, rhinoceros horns, plumes, musical stones, silk, pearls, precious woods, and cinnabar. The mention of yak tails implies trade relations between the middle Yangtze basin and the Tibetan plateau, for the yak is a native of High Asia. Jade, which played such an important rôle in ritual and symbol, seems beyond much doubt to have been procured from the Tarim basin, where it occurs; for it is unlikely that deposits of that much-prized substance ever existed in China proper. Great dogs of a breed probably ancestral to that of the present Mongolian and Tibetan mastiffs were imported from some western region, perhaps the modern province of Kansu. The demand among the landholding class for articles obtainable only at a distance played a large part in the widespread diffusion of culture which we know went on throughout the Chinese Bronze Age.

The routes followed by trade were of course largely fixed by topographical features. The northern Chinese rivers were not of a character to encourage the development of traffic by water, although we know that it occurred. In general, land travel was preferred, and transportation was chiefly by means of pack oxen and oxcarts. The present railways follow some of the principal routes traversed far back in the Chinese Bronze Age. In the south the rivers flow through older and better-defined channels, while on the other hand dense subtropical forests and an extremely rugged relief made movement by land difficult. Hence in that region trade and war were conducted in large dugout canoes propelled by many paddlers. It is interesting to see that in the north today motor buses are coming into general use, while in the south steam launches and motor boats are largely employed.

[25] Concerning these see Sueji Umehara: L'analyse chimique des bronzes anciens de la Chine, *Artibus Asiae*, Volume for 1927, pp. 247–264; also W. Perceval Yetts: Bronzes, in "Chinese Art" (Burlington Magazine Monograph No. 1), London, 1925, pp. 31–46, specifically p. 36 and note 1.

A Revolution in the Art of War

Probably during the latter half of the second millennium before the Christian era there began in the western steppes a revolution in the art of war that was destined to produce far-reaching effects on the history of civilization. This was the employment of bodies of mounted men in fighting,[26] at first with the spear but later with the bow also. In the beginning such troops were subordinate to the chariot forces; but in time, owing to their greater efficiency in combat, they displaced the latter entirely. The practice of fighting on horseback extended itself in various directions, among them to the confines of China. There is some slight reason for thinking it may have been known to the people who drove the chariot-using Chou Dynasty eastward in the eighth century before our era. Two or three hundred years later we find light cavalry, armed with lances, employed along with the traditional chariotry and foot by the Chinese themselves. The latter, about 300 B.C., borrowed the practice of horse archery from their steppe neighbors, as is specifically told.[27] Finally, not long before the beginning of the Christian era, the war chariot disappeared in China, its place in battle being taken by heavy cavalry using shock tactics. This improvement was adopted apparently from the Persians through several intermediaries.[28] The different methods of utilizing the horse in Chinese warfare at various periods afford us some of the clearest and most interesting examples we have of the way in which successive advances in civilization have disseminated themselves along the steppe zone.

Beginnings of the Iron Age

Much interesting and valuable work has been done of late by Chinese scholars on the problem of the beginnings of the Chinese Iron Age. The use of iron began in northern China somewhere around the middle of the first millennium before the Christian era. There are reasons for thinking that it was originally obtained from some region outside the basin of the Hwang Ho. An early Chinese ideograph for "iron" is written with the two elements "barbarian" and "metal." The *Yü Kung*, already cited, speaks of it as imported from the upper Yangtze Valley. Some knowledge of iron appears also to have penetrated the Hwang Ho basin by the steppe route; for toward the close of the first millennium before our era, about the same time as the adoption of heavy cavalry, we begin to find

[26] The use of the horse as a mount instead of a draught animal may have occurred sporadically far earlier; see R. de Mecquenem: Excavations at Susa (Persia), 1930–1931, *Antiquity*, Vol. 5, 1931, pp. 330–343, specifically p. 332 and note.

[27] Édouard Chavannes: Les mémoires historiques de Se-ma Ts'ien, 5 vols., Paris, 1895–1905; reference in Vol. 5, p. 81.

[28] See Berthold Laufer: Chinese Clay Figures, Part I, *Field Museum of Nat. Hist. Publ. 177 (Anthropol. Ser.*, Vol. 13), 1914, p. 232 and *passim*.

employed in northern China long straight iron swords of a well known Western and Central Asiatic type.

Iron working developed more rapidly in central China than it did in the north. This may have been due in part to its having begun earlier in the former area; but the better quality of the iron found in the Yangtze Valley and the ample supplies of charcoal for smelting provided by its luxuriant forests were also of great advantage.

In both northern and southern China the spread of civilization was from the interior of the country toward its periphery. It did not reach the coastal region till well after the beginning of the Chinese historical period. Upon its development the sea exerted comparatively little influence until the appearance of sailing craft in Far Eastern waters, around the beginning of the Christian era.[29] Nevertheless the culture centers of the Yellow River basin must have had contacts of some sort with the coast much earlier; for on Bronze Age sites hundreds of miles inland and belonging to widely sundered epochs there occur various marine products. Among these are large numbers of cowry shells, obtainable only in distant tropical seas; and also, curiously enough, bones of the whale. It seems certain, too, that the trade in sea salt did much to promote cultural diffusions.

The archaic Chinese civilization, essentially of a lowland and agricultural type, was compelled to limit itself rather narrowly, both in peace and in war, to a particular type of terrain. Hence it spread very irregularly along the belts of easiest penetration. In hilly or wooded or swampy tracts it left enclaves of unsubdued peoples closely akin in race to the basic stock of the Chinese themselves but lagging behind culturally on account of their less accessible geographical position. Their absorption was an extremely slow process, even today far from complete in many parts of the west and southwest.

[29] Sailing ships are not mentioned in the Chinese writings until the third century of the Christian era, according to Professor Paul Pelliot (verbal communication of July 21, 1927); but voyages from the Near East to the coasts of Indo-China were being made about the beginning of the Christian era.

WILKES LAND REDISCOVERED

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[With separate map, Pl. V, facing p. 654]

IN 1838 a United States Exploring Expedition commanded by Lieutenant, afterwards Admiral, Charles Wilkes, U. S. N., departed on a four-year cruise destined to circumnavigate the globe and to become famous by reason of establishing the existence of an Antarctic Continent, one of the great discoveries in the history of geography. Though Wilkes in reporting his discovery referred to the land as the "Antarctic Continent" and so represented it on his charts and in their titles, geographers, following established custom, have given the long stretch of 1500 miles of coast land that Wilkes skirted and roughly outlined the name of "Wilkes Land," and so it has appeared on maps and globes since that time.

The importance of Wilkes's discovery was not so much in finding mainland near the Antarctic Circle, for this had been done by Biscoe in 1831 in another sector of the Antarctic, but in proving, by a series of landfalls distributed fairly regularly throughout a stretch of 1500 miles and through 60 degrees of longitude near that circle, that the land discovered had continental dimensions. By a number of soundings he was able further to prove that a continental shelf lay along its front. Moreover, the specimens of rock secured by him from the floating ice were all clearly of the types recognized as continental—granites and sandstones. With our present-day knowledge of the Antarctic Continent we are able to add from the wind directions encountered by him another proof that he was on the margin of an ice-covered continent.[1]

In 1847 the Royal Geographical Society of London, in matters pertaining to exploration the leading society of the world, awarded him the much-prized Founder's Medal, with the citation, "for his Voyage of Discovery in the S. Hemisphere and in the Antarctic Regions, in the years 1838–42, and for the volumes which he has published, detailing the narrative of that expedition."[2]

In his own country, however, there was little early recognition

[1] W. H. Hobbs: The Rôle of the Glacial Anticyclone in the Air Circulation of the Globe, *Proc. Amer. Philos. Soc.*, Vol. 54, 1915, pp. 185–225; reference on p. 216, Fig. 8; *idem*, The Glacial Anticyclones: The Poles of the Atmospheric Circulation (Univ. of Michigan Studies, Scientific Series, Vol. 4), New York, 1926, pp. 6–7, Fig. 3.

[2] *Journ. Royal Geogr. Soc.*, Vol. 19, 1849, p. xxvi. Wilkes's narrative was first published in 1844, see below, footnote 6.

of the greatness of Wilkes's achievement, and he was soon involved in sharp criticism voiced from the floor of Congress and in a court-martial on charges preferred by members of his expedition for cruelty, particularly in the Antarctic region, to which was added among other charges insubordination to his civilian chief. Of all these charges, however, he was acquitted.

Wilkes's discovery was attacked by British explorers and geographers and in those quarters has been in a measure discredited, so that some geographers in Great Britain and France have removed Wilkes Land from their charts. These attacks have been based largely on the action of Sir James Clark Ross, the veteran commander of a rival British expedition which had been forestalled by Lieutenant Wilkes in the discovery of the Antarctic Continent.

The expeditions of Sir Douglas Mawson sailing in the *Aurora* in 1911–1914 and in the *Discovery* in 1930–1931 have now, as will be seen, clearly demonstrated the essential accuracy of Wilkes's establishment of a continental coast line, despite the fact that Mawson has taken occasion to discredit the American explorer on the ground that the charted positions are incorrect. Indeed, Mawson's work, viewed broadly, confirms the existence of land for three-fourths of the distance in the belt in which Wilkes reported it to exist. It is only in the easternmost fifth and in the remaining extreme west of this belt that Wilkes's landfalls have been shown to be erroneous, at least in the positions he assigned to them. On the inaccuracy of the eastern end is based the tendency to a general disparagement of Wilkes's work: by the earlier explorers, because this was the only part of the area with which they were personally familiar; by Mawson, the one explorer whose expeditions have encompassed the whole extent of Wilkes's field of activities, possibly because of what may not unfairly be termed a rather narrow view of the question. To evaluate the evidence it will be necessary to go somewhat fully into the history of exploration within this sector of the Antarctic. A word must also be said about the physical conditions under which Antarctic exploration is carried on.

Physical Conditions Affecting Exploration Near the Border of the Antarctic Continent

The Antarctic Continent, as is now known, is buried under ice and snow, which take the form of a very flat dome of such thickness that no land is visible except near the edges, where in certain areas the summits of hills or mountains may project as rock islands, or nunataks, though much more often they are buried under snow. At many places the snow and ice is so abundant that it spreads from the continent and is floating on the sea, the compacted snow or ice termi-

nating in a steep cliff front that rises above the sea as much as 150 to 250 feet or more. This platform of floating ice is known as "barrier ice" or "shelf ice." Detached masses of shelf ice in the form of tabular snowbergs and icebergs are found floating and drifting in the sea or stranded temporarily in shallower water. These "ice islands" are sometimes miles and even tens of miles in horizontal dimensions, and they are especially abundant near the barrier edge. The surface of the sea itself in these high latitudes is generally frozen as sea ice, which may attain a thickness of eight feet or more. Owing to the terrific winds that blow off the ice onto the sea, the sea ice is apt to be separated from the barrier edge by a lane of open water, and it is this lane that makes exploration by sea possible in the Antarctic. Broken by the force of the wind, the sea ice is changed into floe ice, and this in turn into pack ice or "pack" as a result of strong winds from different directions. The winds drive the floes together with terrific force, some under and others over, producing hummock ice, a network of interlocking ridges.

The barrier ice is not always easy to distinguish from the sea ice, from which it is generally largely derived by accumulation on its surface of the drift snow blown off the continent by the strong blizzards, and by overflow of ice from the continental glacier. The impenetrable barrier ice that Wilkes found skirting the continent he described and represented on his charts as "icy barrier," though it is clear that he includes much pack ice under this description (Pl. V), i.e. a changeable element in comparison with the relatively stable barrier ice.

In any but clear weather, if no rock masses are visible, it is extremely difficult to distinguish ice-covered land from barrier ice or ice islands, and the storms of hurricane force that blow off the continent fill the air almost fluid-thick with snow, while at other times northerly winds blowing toward the continent bring fogs from the sea and greatly add to the explorer's difficulties. The remarkable variation in visibility dependent on differences of weather has made estimates of distance in the Antarctic subject to grave error, and the reported distance and position of land sighted from ships or airplanes, unless controlled by cross bearings or other instrumental checks, have often proved unreliable. A noteworthy instance of error from this cause is the incorrect location attributed to the coast of Mac-Robertson Land[3] by Sir Douglas Mawson on his expedition of 1929–1930. In 1930–1931, when he was able to approach nearer the land, he found that his coast line as mapped the year before was as much as seventy miles too far to the northward.[4]

[3] Lars Christensen Land of the *Norvegia* expedition of 1930–1931. See Gunnar Isachsen: Norwegian Explorations in the Antarctic, 1930–1931, *Geogr. Rev.*, Vol. 22, 1932, pp. 83–96.

[4] *Ibid.*, p. 94, footnote. Also Sir Douglas Mawson: The B. A. N. Z. Antarctic Research Expedition, 1929–1931, *Geogr. Journ.*, Vol. 80, 1932, pp. 101–126; references on pp. 108 and 109.

History of Exploration in the Wilkes Land Sector: Dumont d'Urville

A French expedition consisting of the sailing ships *Astrolabe* and *Zélée* under the command of Captain, afterwards Admiral, J. S. C. Dumont d'Urville, was in Antarctic waters at the same time as Lieutenant Wilkes's squadron. D'Urville sighted the Antarctic Continent at one place, which he named Adélie Land, and the barrier ice to the northwest, which he named Côte Clarie, after which he returned north (Pl. V). D'Urville never claimed that he had discovered a continent, and in the very nature of the case he could not have done so.

On the basis of d'Urville's journal as published,[5] geographers have rather generally held that he anticipated Wilkes in sighting the Antarctic coast, whereas, as will be seen, this is not so, since the dates throughout his log (and his published narrative as well) are one day in advance of the true dates. When d'Urville crossed the 180th meridian on his way to the Antarctic he failed to drop a day, as is clearly shown by his positions on the chart. An instance of this error appears in the record of his meeting with the American ship *Porpoise* of the Wilkes squadron: the date in the log of the *Porpoise* is January 30, the correct date;[6] it appears as January 29 in the log of d'Urville. Twenty months after making his error d'Urville on his approach to Europe records making the correction by dropping a day (June 23, 1840), but he allowed his log tc be published with erroneous dates throughout the Antarctic cruise.[7]

The Nearly Simultaneous Discoveries by d'Urville and Wilkes

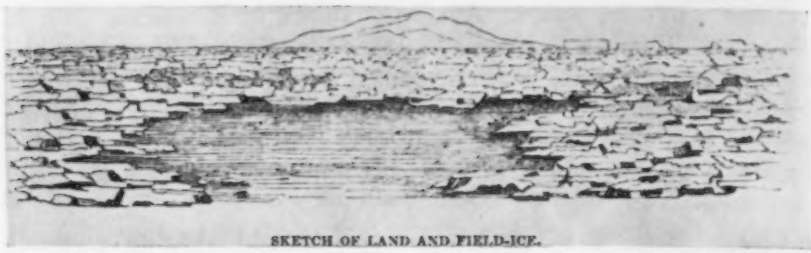
It seems important at this stage to clear up the misunderstanding that has arisen among geographers owing to d'Urville's incorrect dates in his log, because the discoveries of areas of Antarctic land by the two expeditions were very nearly the same. On January 16, 1840, Wilkes thought he saw land, and the same observation was made on other ships of the squadron, but in his later consideration he con-

[5] J. S. C. Dumont d'Urville: Voyage au Pôle Sud et dans l'Océanie sur les corvettes "l'Astrolabe" et la "Zelée" exécuté par ordre du Roi pendant 1837–40 sous le commandement de M. J. Dumont d'Urville: Histoire du Voyage, 23 vols., Paris, 1841–45. The discovery of Adélie Land is dealt with in Vol. 8. For a translation see pp. 436–464 of "The Antarctic Manual for the Use of the Expedition of 1901," edited by George Murray and published by the Royal Geographical Society, London, 1901.

[6] Wilkes in his log records dropping a day where he crossed the 180th meridian. See Charles Wilkes: Narrative of the United States Exploring Expedition During the Years 1838, 1839, 1840, 1841, 1842 (5 vols. and atlas, Philadelphia, edition of 1845), Vol. 2, p. 159.

[7] This discovery we owe to Rear Admiral John E. Pillsbury, U. S. N., who published an article under the title "Wilkes' and d'Urville's Discoveries in Wilkes Land" in the *Natl. Geogr. Mag.*, Vol. 21, 1910, pp. 171–173, and the *Proc. U. S. Naval Inst.*, Vol. 36, 1910, pp. 465–468. Pillsbury himself noticed the discrepancy when he charted the tracks of d'Urville's and Wilkes's vessels. It seems, however, to be little known even to students of Antarctic exploration.

cluded that this land was an island or islands surrounded by a vast area of ice.[8] Of Ringgold's Knoll, the easternmost of the mountains, he supplied a sketch which might support this view (Fig. 1) or it might represent a peak of land mainly below the horizon (see below, p. 643).



SKETCH OF LAND AND FIELD-ICE.

FIG. 1—Ringgold's Knoll, reproduced from Wilkes's "Narrative" (Philadelphia, 1845, Vol. 2, p. 294.)

Wilkes first became convinced that he saw a larger area of land on January 19 (Cape Hudson) at about eight o'clock in the morning. By a remarkable coincidence it was on the succeeding day, though given as January 19 by d'Urville, at a point some 300 miles farther west and at a later hour (three o'clock) that d'Urville sighted his first land, Adélie Land. On the assumption (see below, p. 643) that Cape Hudson was land, although not in the position as charted by Wilkes, the priority of the discovery of land in the Australian sector of the Antarctic as between d'Urville and Wilkes would therefore be held by Wilkes, but by a margin of about a day and a half; and until the error in d'Urville's date was discovered, the credit had been thought by many to belong to d'Urville.

Wilkes's description of the land discovered by his expedition on January 19, 1840, is clear. This land stretched to the southeast, south, and southwest (see Fig. 2).

> On the morning of the 19th, we found ourselves in a deep bay, and discovered the Peacock standing to the southwest. Until eight o'clock, a. m., we had a moderate breeze. The water was of a darker olive-green, and had a muddy appearance. Land was now certainly visible from the Vincennes, both to the south-southeast and southwest, in the former direction most distinctly. Both appeared high. It was between eight and nine in the morning when I was fully satisfied that it was certainly land, and my own opinion was confirmed by that of some of the oldest and most experienced seamen on board. The officer of the morning watch, Lieutenant Alden, sent twice, and called my attention to it. We were at this time in longitude 154° 30′ E., latitude 66° 20′ S.; the day was fine, and at times quite clear, with light winds. After divine service, I still saw the outline of the land, unchanged in form, but not so distinct as in the morning . . .
>
> The Peacock, at 3h 30m, according to Captain Hudson's journal, having got into the drift-ice, with a barrier still ahead to the west, tacked to the southeast to work up for an immense mass, which had every appearance of land, and which was believed to be such by all on board. It was seen far beyond and towering above

[8] "I am strongly of the opinion it is an island, surrounded by immense fields of ice now in sight" (Ringgold's report, in Wilkes, Narrative, edition of 1845, Vol. 2, p. 470). On Wilkes's map the discoveries of this day are given southern boundaries, the only examples that his map reveals (Pl. V).

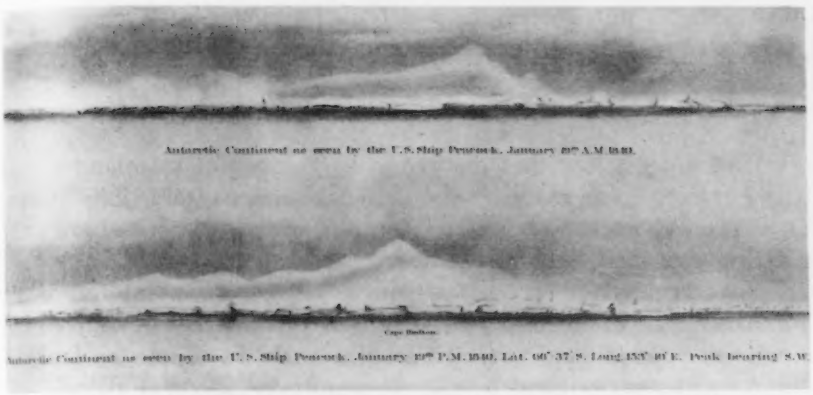


FIG. 2—Sketches of Cape Hudson by Wilkes from his "Chart of the Antarctic Continent," in the atlas accompanying the "Narrative."

an ice-island that was from one hundred and fifty to two hundred feet in height. It bore from them about southwest, and had the appearance of being three thousand feet in height, forming a sort of amphitheatre, looking gray and dark, and divided into two distinct ridges or elevations throughout its entire extent, the whole being covered with snow. As there was no probability of getting nearer to it in this quarter, they stood out of the bay, which was about twenty miles deep, to proceed to the westward, hoping to get an opportunity to approach the object more closely on the other side.[9]

In view of the controversy that was waged it is perhaps fortunate that, in the court-martial of Captain Wilkes after his return to America, one of his officers made the charge that he had falsified his statement concerning the discovery of land on January 19, for

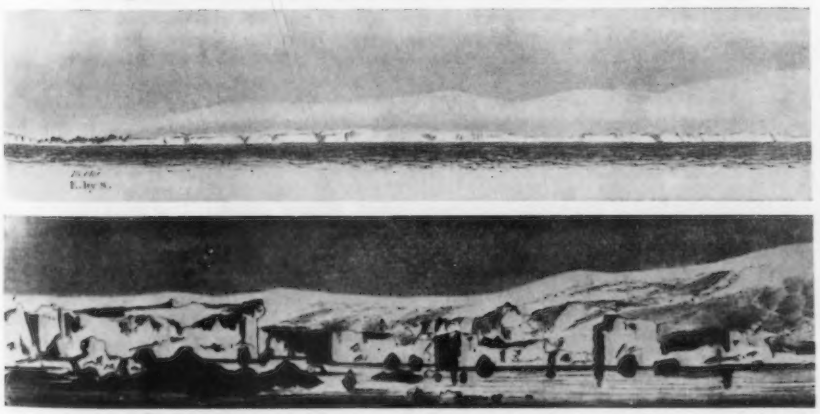


FIG. 3—A part of the Adélie Land coast in 140° E. as sketched by Wilkes (above) and d'Urville (below). Wilkes's sketch, the head of Piner's Bay, is from his "Chart of the Antarctic Continent"; d'Urville's sketch, Pointe Géologie, is from the "Atlas Hydrographique" by C. A. Vincendon-Dumoulin, Paris, 1847, Pl. 35, accompanying Dumont d'Urville's "Voyage au Pôle Sud." Note the word "Rocks" on the left of Wilkes's sketch.

[9] *Ibid.*, Vol. 2, pp. 295–296.

this brought out independent sworn testimony by a considerable number of officers and men. Some of this testimony was published.[10]

Biscoe's Discovery of Enderby Land in 1831

Undoubtedly the first discovery of continental mainland within the Antarctic[11] was made by the British sealing captain, John Biscoe, in February, 1831. After observing phenomena associated with the proximity of land, such as the discoloration of the sea water and the frequent occurrence of whales, penguins, and seals, intermittently for a distance of about 1200 miles east of longitude 5° E., Biscoe finally discovered land in about longitude 50° E. (Enderby Land).[12] Land was actually found by the *Norvegia* expeditions of 1929–1930[13] and 1930–1931 in the long stretch west of Enderby Land where Biscoe had suspected its proximity,[14] and the British and the Norwegian expeditions of 1929–1930 under Mawson[15] and Riiser-Larsen respectively set foot on Enderby Land.

Balleny's Sabrina Land

There is a probable landfall within the Australian sector of the Antarctic Continent which was made a year earlier than either the Wilkes or d'Urville expedition by a British sealing captain, John Balleny, who upon the same cruise discovered the Balleny Islands northeast of Wilkes Land. Balleny sailed with two small vessels, the schooner *Eliza Scott* and the cutter *Sabrina*. No contemporary chart of his cruise was published,[16] and no map of the position of his

[10] In a pamphlet printed probably in Washington in 1842 and entitled "Defence: The following defence of Lieut. Charles Wilkes to the charges on which he has been tried is respectfully submitted to the court." Copies in Harvard College Library and the Library of Congress; cited by E. S. Balch in "Antarctica" (Allen, Lane, and Scott, Philadelphia, 1902), a classical, but not extremely rare work.

[11] The recent discovery (1928) by Sir Hubert Wilkins that West Antarctica within the South American sector of the Antarctic, which until that time had been regarded as a peninsular projection of the continent, is in reality an archipelago separated from the continent itself by a strait some fifty miles in width has greatly simplified the question of the real discovery of the Antarctic Continent. As early as the seventeenth and eighteenth centuries ship captains in rounding Cape Horn had in some cases been driven far from their courses by the terrific storms prevailing there, so that they had come into the neighborhood of this group of Antarctic islands. Wilkins' discovery thus limits the discovery of the continent to the group of explorers who in the first half of the last century entered the Antarctic within the eastern sectors.

[12] Biscoe saw "appearances of land" on January 21 (long. 0° 24′ E.), February 1 and 4 (long. 14° 42′ E.). On February 25 (long. 45° 17′ E.) better observations were possible and features of the land were made out, and on February 28 (long. 47° 20′ E.) the black tops of mountains were seen protruding. On March 3 (long. 49° 29′ E.) a high mountain promontory was seen and named Cape Ann (long. 49° 18′ E.), which was seen again on March 17. Again on March 28 in longitude 55° 17′ E. land was seen for the last time (from Biscoe's Journal printed in the Antarctic Manual, pp. 314–324).

[13] See Hjalmar Riiser-Larsen: The "Norvegia" Antarctic Expedition of 1929–1930, *Geogr. Rev.*, Vol. 20, 1930, pp. 555–573.

[14] See Gunnar Isachsen: Norwegian Explorations in the Antarctic, 1930–1931, *ibid.*, Vol. 22, 1932, pp. 83–96.

[15] See Sir Douglas Mawson: The Antarctic Cruise of the "Discovery," 1929–1930, *ibid.*, Vol. 20, 1930, pp. 535–554; Hjalmar Riiser-Larsen, *op. cit.*

[16] His route has been reconstructed from his log on Sheet No. 1 of the map in three sheets accompanying the Antarctic Manual.

landfall; but the position of the ship is given. This landfall was later incorporated on maps as Sabrina Land, but it is obvious that no claim to discovery of the Antarctic Continent was made or could be made upon it.[17]

Ross and Wilkes

Nearly a year after both Wilkes and d'Urville had completed their Antarctic cruises a British expedition under the veteran polar explorer, Sir James Clark Ross, entered the Antarctic region. Ross sailed in two fine ships, the *Erebus* and the *Terror*, which in their preparation for hard service in ice and in their equipment were in striking contrast with the ill-found ships of both Wilkes and d'Urville. To serve as a guide for his exploratory work Wilkes sent to Ross from New Zealand a long letter detailing his discoveries and, in addition, supplied him with a tracing made from a preliminary chart of his cruise.[18] This, in the event as will be seen, proved an unwise courtesy.

Ross's expedition discovered land in another section of the Antarctic lying to the eastward of Wilkes Land and, in honor of his sovereign, he named it Victoria Land (now South Victoria Land to distinguish it from Victoria in Australia). He also discovered the Ross Sea and the great Ross Barrier of shelf ice and mapped its front for a distance of about 500 miles. He discovered the volcanoes Erebus and Terror, on Ross Island near the western termination of the front of the Ross Barrier, and also the great Admiralty Range of mountains in South Victoria Land. His Parry Mountains and Russell Islands were later shown by Scott to be nonexistent (see below, p. 644).

Ross chose to consider himself ill-treated by both d'Urville and Wilkes, whom he charged with improper motives in making their

[17] Balleny's log is very brief: "March 2nd [1839] A. M.—Squally from the S. E., with snow and sleet. At 8 cleared off a little. At noon, lat. obs. 64° 58′, long. 121° 8′, therm. 35°. P. M., Strong winds, and showers of snow and sleet; saw a great many birds. At 8, the water becoming smooth all at once, shortened sail, and hove-to. Saw land to the southward, the vessel surrounded by drift ice . . .

"March 3rd, A. M.—Found the ice closing and becoming more compact; stood through the drift ice to the southward. At 8 h. found ourselves surrounded by icebergs of immense size; to the S. W. the ice was quite fast, with every appearance of land at the back of it, but, the weather coming on thick, were obliged to steer to the northward along the edge of the pack. At noon, lat. by obs. 65° 10′, long. 117° 4′. P. M., Fresh breezes from the S. S. E. and clear; numerous icebergs in sight" (Charles Enderby: Discoveries in the Antarctic Ocean, in February 1839. Extracted from the Journal of the schooner Eliza Scott, commanded by Mr. John Balleny, *Journ. Royal Geogr. Soc.*, Vol. 9, 1839, pp. 417–528; reference on p. 525).

The log of the second mate reads under date of March 3: "At 8 it cleared off a little. Saw the appearance of land to the south, but there being so much ice between the vessels and it, we were glad to get out again safe . . . At 11, still saw the appearance of land to the west, but it coming on thick, and the vessels surrounded with ice, we steered as requisite to gain the open sea" (Antarctic Manual, p. 355).

[18] The letter is published in Wilkes, Narrative, edition of 1845, Vol. 2, pp. 453–456 (Appendix 24) and in Sir James Clark Ross: A Voyage of Discovery and Research in the Southern and Antarctic Regions during the Years 1839–43 (2 vols., London, 1847), Vol. 1, pp. 346–352 (Appendix 6, accompanied by a copy of the tracing).

discoveries in advance of him,[19] though the American expedition had been announced in England in 1836,[20] while the Ross expedition resulted from a series of resolutions adopted by the British Association for the Advancement of Science in 1838. Ross chose to direct his attacks chiefly against Wilkes, claiming that his discoveries were not substantiated. He also made much of Balleny's "Sabrina Land" to show that Wilkes had been forestalled in his discovery of the Antarctic Continent.[21] He even asserted that there was no Antarctic Continent proved. He says:[22]

> There do not appear to me sufficient grounds to justify the assertion that the various patches of land recently discovered by the American, French, and English navigators on the verge of the Antarctic Circle unite to form a great southern continent. The continuity of the largest of these "Terre Adélie" of M. D'Urville had not been traced more than three hundred miles, Enderby's Land not exceeding two hundred miles: the others being mostly of inconsiderable extent, of somewhat uncertain determination, and with wide channels between them, would lead rather to the conclusion that they form a chain of islands.

The extension by Ross of the Adélie Land coast from its real length of 175 miles to 300 miles and the characterization of all Wilkes's landfalls as "of inconsiderable extent, of somewhat uncertain determination, and with wide channels between them" are of course quite absurd. Wilkes expressly states:[23]

> Along the Antarctic Continent for the whole distance explored, which is upwards of fifteen hundred miles, no open strait is found . . . If there was only a chain of islands, the outline of the ice would undoubtedly be of another form.

To his attacks upon Wilkes, Ross added an assertion that the *Erebus* and *Terror* had sailed over Wilkes Land, and, although he had at the time the corrected official map as published by Wilkes, he did

[19] "That the commanders of each of these great national undertakings should have selected the very place for penetrating to the southward, for the exploration of which they were well aware, at the time, that the expedition under my command was expressly preparing, and thereby forestalling our purposes, did certainly greatly surprise me. I should have expected their national pride would have caused them rather to have chosen any other path in the wide field before them, than one thus pointed out, if no higher consideration had power to prevent such an interference" (Ross, A Voyage, Vol. 1, pp. 116–117).

[20] *Journ. Royal Geogr. Soc.*, Vol. 6, 1836, p. 440.

[21] Concerning Sabrina Land Ross wrote: "According to Lieutenant Wilkes's chart, the Vincennes must have passed this land, in nearly the same latitude as Balleny did, during the night of the 10th, or the thick snowy weather of the following day, and without seeing it, as no mention is made of it in the narrative. I suppose, therefore, he has placed it on his chart on the authority of Balleny, but under a different name. He has called it 'Totten's high land.'

"I have inserted these several extracts with the view to do justice to the exertions and courage of Captain Balleny and his companions, and to prevent their being deprived of their due share in the honour of a discovery, for the priority of which the Americans and French are contending with each other, and to which, should this land eventually prove to be a continent extending to Kemp and Enderby Land, as they suppose, it follows that neither of them have the smallest claim whatever; although equal praise is due to them for their exertions and perseverance as if they had really been the discoverers, for at that time they could not have known that Balleny had been there the year before them" (Ross, A Voyage, Vol. 1, pp. 274–275).

[22] *Ibid.*, Vol. 1, p. 275.

[23] Wilkes, Narrative, edition of 1845, Vol. 2, p. 335.

not hesitate to publish in his report the rough chart that Wilkes had generously furnished him and on which Wilkes had entered by a rather indefinite patch the Balleny island area (Pl. V)[24] and also a position where on January 13 on the *Porpoise* Ringgold "thought he could discern to the southeast something like distant mountains." It is according to Wilkes's report no part of the Antarctic Continent, as shown by his chart (Pl. V), since the patch sailed over is according to Ross in latitude 65° 30′ S. and longitude 165° E., whereas the easternmost land on Wilkes's chart is indicated in longitude 158° E., and even the lettering of the name "Antarctic Continent" does not extend beyond 161° E. Yet much has been made of this statement of Ross by the later British explorers.

Sir Clements Markham and Wilkes

After the conclusion of the Ross expedition exploration of the Antarctic region was largely neglected for more than half a century, but the controversy was revived by Sir Clements Markham. In his article on "Polar Regions" in the ninth edition of the Encyclopaedia Britannica (1885), Markham states that Wilkes had mapped "a large tract of land in the latitude of the Antarctic Circle for which he claimed the discovery. But as a portion of it had already been seen by Balleny, and the rest has since been proved not to exist, the claim has not been admitted." Furthermore, in his anniversary address before the Royal Geographical Society, 1897, Markham ascribed to Ross the discovery of the Antarctic Continent.[25] Yet the Society he was addressing as president had awarded to Wilkes its much prized gold Founder's Medal for his Antarctic expedition. In a paper read before the International Geographical Congress at Berlin in 1899[26] Markham completely ignored all American explorers of the Antarctic and suggested that the Antarctic region might well be divided into four quadrant sectors to be named respectively after Victoria, the British sovereign (this is the quadrant in which Wilkes Land lies); after Ross; after the British sealing captain Weddell; and after the British manager of the sealing industry, Enderby. This did not appeal to the Congress, but a London publisher brought out a map on this plan.[27] Markham was a promoter of the Antarctic

[24] Ross, A Voyage, Vol. 1, pp. 279–280, and map opposite p. 352. On Wilkes's reason for the differing representation of the patch of land see H. R. Mill: The Siege of the South Pole, London, 1905, pp. 246–247, and the interchange of letters between Lieutenant Wilkes and Captain Aulick reprinted from the *Spectator* in Ross, A Voyage, Vol. 1, pp. 353–359 (Appendixes 7 and 8).

[25] "In one short month he (Ross) made one of the greatest geographical discoveries of modern times . . . including a southern continent, which was named Victoria Land . . . This may fairly be considered to have been the only real antarctic expedition" (*Geogr. Journ.*, Vol. 9, 1897, pp. 592–593).

[26] The Antarctic Expeditions, Verhandl. Siebenten Internationalen Geographen-Kongresses, Berlin, 1901, Vol. 2, pp. 623–630.

[27] Edward Stanford, South Polar Chart, 1901 (cited by Balch, Antarctica, p. 13, footnote). On Markham's proposals see also E. S. Balch: Antarctic Nomenclature, *Bull. Amer. Geogr. Soc.*, Vol. 37, 1905, pp. 718–720.

cruises of Borchgrevink in the *Southern Cross* in 1898–1900 and of Scott's first expedition (1901–1902).[28]

Scott and Other Recent British Explorers

Borchgrevink, following the example of Ross, sailed over the same site that had been rather indefinitely located on the rough chart supplied to Ross by Wilkes. He published a map similar to that of Ross and bearing the exaggerated legend, "Track of S. Y. 'Southern Cross' over Wilkes Land":[29] Wilkes Land referred merely to the patch in 65½° S. and 165° E. For Scott's expedition the Royal Geographical Society prepared "The Antarctic Manual" with a map on which Knox Land alone of all the landfalls of Wilkes was entered.[30]

On his first expedition at the opening of the new century Scott was the first among British explorers to push westward toward the real field of discoveries of Wilkes. He was able to sail to the southward of certain charted positions of Wilkes (Ringgold's Knoll and Eld's and Reynold's Peaks), and near enough to the charted position of Cape Hudson to show on the basis of the prevailing clear weather that, if it existed, it was not in the charted position (Pl. V).

Forgetting, apparently, that he had seen the charted position only of the extreme eastern limit of Wilkes Land, which extended 1500 miles to the westward upon Wilkes's map, Scott set down in his narrative, " . . . thus once and for all we have definitely disposed of Wilkes Land." He says further:[31]

> In the course of this narrative I shall show that the mountainous lands reported by Wilkes to the eastward of Adélie Land do not exist, and it must be recognised that those to the west may be equally unsubstantial, but it is not clear that Wilkes wilfully perverted the truth . . . It must be supposed also . . . that Wilkes . . . expected to find land about the Antarctic Circle, and when after his return he learned of D'Urville's discoveries, the position of Adélie Land would naturally have tended to dispel any doubt which he may have had as to what he or his people had seen.

Captain Scott was at the time new to the Antarctic and may not have realized the deceptive element in distance estimates in such regions. The language of Wilkes and his officers (ante, p. 636) is such as to show that they saw mountainous land on which could be

[28] Up to the year 1902, or just before the first Scott expedition to the Antarctic, the attacks upon Wilkes by British explorers and geographers were answered by Balch in "Antarctica" (see footnote 10). In addition to the article cited in the preceding footnote see also the following short articles by Mr. Balch in the *Bull. Amer. Geogr. Soc.*: "Wilkes Land," Vol. 38, 1906, pp. 30–32; "Hudson Land," Vol. 43, 1911, pp. 445–446; "Recent Antarctic Discoveries," Vol. 44, 1912, pp. 161–167; and the anonymous note "Tablets in Memory of Wilkes and Palmer," Vol. 46, 1914, pp. 830–831.

[29] C. E. Borchgrevink: First on the Antarctic Continent, London, 1901, second chart at end of volume.

[30] Work cited in footnote 16.

[31] R. F. Scott: The Voyage of the "Discovery" (2 vols., New York and London, 1905), Vol. 1, p. 19

made out the distinctive features and these were also represented in sketches (Figs. 2 and 3). Now that the coast of King George V Land has been found by Mawson in 1912 to the southward of Wilkes's charted position of Cape Hudson and in the direction in which he saw it, there is no reasonable ground for supposing that the eastward extension of this is not the land seen by Wilkes and his officers. It is indeed 130 miles or more away from the position of their vessel, but in the clear air occasionally met with in such regions and raised by the mirage[32] so common there, it is quite within the bounds of probability that this was the land discovered by Wilkes on January 19, 1840.

In 1915 land was distinctly seen from the *Aurora* of Shackleton's Ross Sea party in Wilkes's charted direction of Cape Hudson (King George V Land) and at about the same time to the eastward one of the Balleny Islands at a distance of at least 160 miles. The *Aurora's* log is most illuminating in illustrating the difficulties that face the Antarctic explorer because of the constantly changing clarity of the atmosphere:

> November 23.—At 3 a. m. Young Island, Balleny Group, was seen bearing north 54° east (true). The island, which showed up clearly on the horizon, under a heavy stratus-covered sky, appeared to be very far distant. By latitude at noon we are in 66° 26′ S. As this is the charted latitude of Peak Foreman, Young Island, the bearing does not agree. Land was seen at 8 a. m. bearing south 60° west (true). This, which would appear to be Cape Hudson, loomed up through the mists in the form of a high, bold headland, with low undulating land stretching away to the south-southeast and to the westward of it. The appearance of this headland has been foretold for the last two days by masses of black fog, but it seems strange that land so high should not have been seen before, as there is little change in the atmospheric conditions.
>
> November 24.—Overcast and hazy during forenoon. Cloudy, clear, and fine in afternoon and evening. Not a vestige of land can be seen, so Cape Hudson is really "Cape Flyaway." This is most weird. All hands saw the headland to the south-west, and some of us sketched it. Now (afternoon), although the sky is beautifully clear to the south-west, nothing can be seen. We cannot have drifted far from yesterday's position. No wonder Wilkes reported land. 9 p. m.—A low fringe of land appears on the horizon bearing south-west, but in no way resembles our Cape of yesterday. This afternoon we took a cast of the lead through the crack 200 yds. west of the ship, but found no bottom at 700 fathoms.[33]

[32] The conditions about the continental glacier of Greenland are entirely similar. The glacial anticyclone about the inland ice brings warm air to the surface beneath colder air above, and these are the essential conditions for mirage. Mirage there is a common occurrence. Under such conditions, there is no difficulty in making out objects at a distance of 100 miles or more. From Mt. Evans in Greenland near the borders of the inland ice we have on rare occasions on an especially clear day seen wholly new panoramas of mountains raised into view and apparently brought up close. On such occasions it has been possible to follow with a theodolite the course of a pilot balloon with initial diameter of 30 inches at a horizontal distance of 28 miles, and de Quervain followed one at about the same distance. Several striking examples are cited by the British Arctic Air Route Expedition, thus when raised by mirage Mt. Forel was clearly seen from the ice-cap station 140 miles away. Other examples are reported by the Wegener Greenland Expedition.

Mawson himself acknowledges that "the clarity of the Antarctic atmosphere during fine weather results in a wonderful degree of visibility, easily misleading in regard to distance" (*Geogr. Journ.*, Vol. 80, 1932, p. 120; see also pp. 107, 108, 124).

[33] Sir Ernest Shackleton: South: The Story of Shackleton's Last Expedition 1914–1917, New York, 1920, p. 332.

As near as the ship's position can be determined on the basis of the log, it was perhaps twenty miles east of the position of Wilkes's vessels when Cape Hudson was first seen. The coast was doubtless farther south and near where located by Mawson.

Scott asserted that the high range of mountains to the south of Mt. Terror, which Ross had named the Parry Mountains and described as "probably higher than anything we have yet seen" did not exist.[34] It is fair to assume, however, that in an unusually trans-

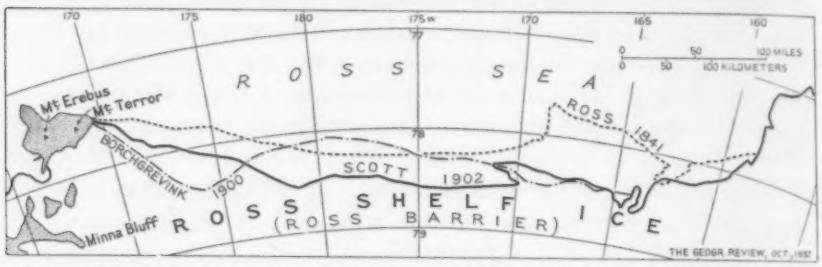


FIG. 4—Comparison of the position of the front of the Ross Barrier as represented by Ross, Borchgrevink, and Scott.

parent atmosphere Minna Bluff, a hundred miles or more to the southwest, was visible to Ross at the time. Scott was also able to show that Ross's Russell Islands, a group of three, which he could not find in their charted positions, were in reality one island, Sturge Island, of the Balleny group.[35] The Balleny Islands have caused much trouble. Wilkes's doubtful loom of land on January 13 was very probably over the northern islands of this group (Pl. V).

Scott also cruised along the front of the great Ross Barrier, as Ross himself had done sixty years before. Scott's detailed survey of the front showed that the Ross map gave the position of much of the ice cliff as twenty to thirty miles farther north than his own, and he actually sailed over much of the barrier as mapped by Ross. Scott did not for this reason charge his countryman either with bad navigation or with falsifying his records. He reached the alternative conclusion that during the sixty odd years that had intervened since Ross skirted the barrier the barrier front had receded the amount indicated by the difference between their maps; and in this view glacialists have concurred, though we may now believe that the discrepancy is due largely to Ross's error in estimating distances to the cliff. Scott's map in better weather and with steam power is practically a traverse along the front of the cliff and probably approximated the correct position. Borchgrevink's map of 1900 is as divergent as Ross's of 1841 (see Fig. 4). It is certain that recession of part of the "icy barrier" described by Wilkes has also occurred. In fact, convincing

[34] Scott, Voyage of the "Discovery," Vol. 1, pp. 161, 170–171, and 213.
[35] *Ibid.*, Vol. 2, p 389.

proof of this has been supplied by Mawson, for he has found at the western end of Wilkes Land that the Termination Ice Tongue, a mass of shelf ice which he had himself mapped in February, 1912, and February, 1914, and which then pushed out from the land some sixty or more miles with an average width of about ten miles, had in the twenty-year interval absolutely disappeared. As a consequence, the deep embayment which he had named Davis Sea in honor of his skipper, John K. Davis, is now much restricted.[36]

By the time of Shackleton's Antarctic Expedition (1907–1909) it had become a fixed habit of British explorers to sail over the imaginary "Wilkes Land" of Ross, and Shackleton made the attempt but was stopped by the ice. He was therefore forced to content himself by saying, "The *Discovery* [of Scott's first expedition] had passed through the Balleny Islands and sailed over part of the so-called Wilkes Land of the maps, but the question of the existence of this land in any other position had been left open."[37]

On Scott's last expedition his ship, the *Terra Nova*, under Lieutenant H. L. Pennell, on returning to New Zealand after having landed the shore party, succeeded in February, 1911, in pushing to the westward beyond Cape North and so made clear that the northern coast of South Victoria Land extends in a northwesterly direction over two hundred miles. This section was named "Oates Land." The weather along the path of the *Terra Nova* farther north (see Pl. V) was such that, although her track passed only ten miles from Young Island of the Balleny group, it could not be made out as it was "covered in clouds."[38]

For nearly three-quarters of a century, then, after Wilkes had made his Antarctic cruise and had charted roughly the shores of a southern continent, no explorers except Scott in the *Discovery* and Pennell in the *Terra Nova* had as much as approached this stretch of coast land of more than fifteen hundred miles that had been named Wilkes Land. They had come near its easternmost limit only. Its westernmost limit had been approached only on the *Challenger* expedition in 1874[39] and in 1902 on the first German expedition to the Antarctic in 1901–1903 under Erich von Drygalski. The main field of activity of the latter lay farther westward and had confined its attention to the area beyond Wilkes Land. The chart of Drygalski

[36] Sir Douglas Mawson, The Home of the Blizzard (2 vols., Philadelphia, 1915), Vol. 1, p. 77, and Map of Queen Mary Land, 1 : 1,500,000, accompanying Vol. 2 and J. K. Davis: With the "Aurora" in the Antarctic, 1911–1914, London, 1919, pp. 49, 54, 145–146, and 151–153 (conditions of 1912–14); Mawson's radio despatches from the field on Jan. 31 and Feb. 5, published in *New York Times*, Feb. 3 and 7, 1931, and *Geogr. Journ.*, Vol. 80, 1932, p. 118 (conditions in 1931).

[37] E. H. Shackleton: The Heart of the Antarctic (2 vols., Philadelphia, 1904), Vol. 2, p. 229.

[38] Leonard Huxley, edit.: Scott's Last Expedition (2 vols., New York, 1913), Vol. 2, p. 251 and map opposite p. 278.

[39] Report on the Scientific Results of the Voyage of H. M. S. Challenger During the Years 1873–76: Narrative, Vol. 1, Part I, London, 1885, pp. 403–404 and map facing p. 397, and Summary of the Scientific Results, Part I, London, 1895, p. 501 and map facing p. 502.

indicated, however, as "Wilkes Land" the stretch of coast which lay to the eastward and which had been skirted by Wilkes.[40]

Mawson's Expedition of 1911–1914

The Australasian Antarctic Expedition under Sir Douglas Mawson in 1911–1914 was the first actually to reach and set foot on Wilkes Land. Mawson established his main base on the Wilkes Land coast in longitude 142½° E., retaining for this part the name Adélie Land of d'Urville, who had first seen it at this point, but which was seen by Wilkes six days later. The land to the westward beyond the limits of Wilkes Land, in which his secondary base was established (in 95° E.), Mawson named Queen Mary Land, and an extension of Adélie Land to the southeast he named King George V Land (probably the Cape Hudson of Wilkes, as has already been stated, p. 643).

Following British tradition Mawson erased from his map every name given by Wilkes except Knox Land, and so far as his chart was concerned the U. S. Exploring Expedition was a myth. The following citations (italics not in the original) are from Mawson's narrative:[41]

> Land was reported almost daily [by Wilkes], but, *unfortunately, subsequent exploration has shown that most of the landfalls do not exist.* Several soundings made by Wilkes were indicative of the approach to land, but he must have frequently mistaken for it distant ice-masses frozen in the pack (Vol. 1, p. 9).
>
> Whatever the cause of Wilkes's errors, the truth remains that Ross sailed over land indicated in a rough chart which had been forwarded to him by Wilkes, just before the British expedition set out. More recently Captain Scott in the *Discovery erased many of the landfalls of Wilkes, and now we have still further reduced their number* . . . After the voyage of the *Discovery*, the landfalls, the existence of which had not been disproved, might well have been regarded as requiring confirmation before their validity could be recognised.
>
> The only spot where rocks were reported *in situ* was in Adelie Land, where the French had anticipated the Americans by seven [six] days. Farther west, earth and stones had been collected by Wilkes from material embedded in floating masses of ice off the coast of his Knox Land. These facts lend credence to Wilkes's claims of land in that vicinity. His expedition did not once set foot on Antarctic shores, and, possibly *on account of the absence of the scientific staff, his descriptions tend to be inexact and obscure.* The soundings made by Wilkes were sufficient to show that he was probably in some places at no great distance from the coast, and, considering that his work was carried out in the days of sailing-ships, in unsuitable craft, under the most adverse weather conditions, with crews scurvy-stricken and discontented, it is wonderful how much was achieved. We may amply testify that he did more than open the field for future expeditions (pp. 9–10).
>
> With regard to the Antarctic land to be expected ahead, *many of Wilkes's landfalls, where they had been investigated by later expeditions, had been disproved.* It seemed as if he had regarded the northern margin of the solid floe and shelf-ice as land; perhaps also mistaking bergs, frozen in the floe and distorted by mirage.

[40] Erich von Drygalski: Zum Kontinent des eisigen Südens, Berlin, 1904, map at end of volume; also map in scientific reports (Deutsche Südpolar-Expedition 1901–1903), Vol. 1, No. 4, Berlin, 1921, Pl. 17.

[41] Mawson, *op. cit.*

for ice-covered land. Nevertheless, his soundings, and the light thrown upon the subject by the Scott and Shackleton expeditions, left no doubt in my mind that land would be found within a reasonable distance south of the position assigned by Wilkes (p. 50).

We sailed over the charted position of land east of Wilkes's Cape Carr in clear weather . . . At 5.30 P. M. land was sited to the southward—snowy highlands similar to those of Adelie Land but greater in elevation . . . To this country, *which had never before been seen*, was given the name of Wilkes's Land; as it is only just to commemorate the American Exploring Expedition on *the Continent which its leader believed he had discovered* in these seas and which he would have found had Fortune favoured him with a fair return for his heroic endeavours (p. 72).

At this point any analogy which could possibly have been found with Wilkes's coastline ceased. It seems probable that he charted as land the limits of the pack-ice in 1840 (p. 331).

The insinuation that Wilkes generally took ice for land is answered by Wilkes's map on which he indicates the margin of each separately. The allegations about Wilkes's inaccuracies and his lack of scientific aides are peculiarly unwarranted, since Wilkes was a scientist of parts, as is clearly indicated in his writings. One wonders why Mawson should say of Wilkes, "His expedition did not once set foot on Antarctic shores," since he was of course well aware, though his lay reader may not be, that, as regards the mainland, the same was true of all rival expeditions—French and British alike—and more than half a century was to elapse before Borchgrevink, upon maintaining a precarious foothold on the continent, could justly claim that he was "first on the Antarctic Continent."

That the landfalls of Wilkes's viewed from the sea and the distance estimated should not be accurately charted was to be expected and in fact could not be avoided. The indefiniteness of the margins on Wilkes's map shows his recognition of this fact. It is an inevitable characteristic of all Antarctic expeditions, including the latest by Mawson himself, for all cases where a landing has not been made.

Mawson's Expedition of 1930–1931

In the southern summer of 1930–1931 Mawson in the renovated *Discovery* has cruised along the coast of Wilkes Land and, as stated near the beginning of this article, has furnished a striking confirmation of the essential correctness of Wilkes's discovery nearly a century ago of the coast of the great Antarctic Continent, since called Wilkes Land by most geographers. This confirmation is indicated on Plate V. On this map are shown Mawson's route and landfalls.[42] We have

[42] These were sketched in on the basis of Mawson's radio despatches from the field as follows: *New York Times*, Dec. 28, 1930; Jan. 1, 3, 6, 7, 10, 14, 17, 18, 21, 24, 29; Feb. 3, 7, 12, 13, 18, 21, 24; March 6, 8, 12, 14, 1931, and summaries on March 20 and June 28, 1931. While this article was going through the press the account of the expedition's work in the August, 1932, number of the *Geographical Journal* (see footnote 4) became available and Mawson's route on Plate V was revised accordingly.

no warrant that his landfalls are themselves in correct positions. As regards longitude, the odds greatly favor Mawson, since he has had the advantage of the daily noon signal by radio for a time correction. Furthermore, the use of steam power has permitted his ship to get nearer to the coast.

Despite his general confirmation of Wilkes, there is no admission of this by Mawson, who states:[43]

> Shortly summarizing the achievements of this season's operations, . . . sufficient evidence has now been accumulated to state that land does not exist in the latitudes assigned for North's High Land, Totten's High Land, or Budd's Land, which have appeared on some published maps.
>
> In the case of Knox Land, however, ice-covered land does exist in the neighborhood of the position assigned to it by Wilkes.

Again, in the article in the August number of the *Geographical Journal* Mawson says of Budd's Land that "land does not exist in the position indicated on Wilkes's chart" (p. 117) and it is presumably Knox Land to which he is referring when he says (p. 122):

> The Wilkes Expedition certainly deserves more credit than has usually been accorded to that superhuman effort. Not only did they discover d'Urville's Adelie Land, but they also sighted new land elsewhere within that region then entirely unknown. Information supplied by that expedition regarding the weather and the pack-ice conditions prevailing throughout the whole summer season is of permanent value and in itself a meritorious achievement.

Mawson has given the name Wilkes Land to the extremely short section of coast near 134°, not to commemorate the discoveries made by Wilkes but, as his language makes clear, *those that he might have made but did not.* Yet Wilkes represented a coast in this longitude, on an average some forty to fifty miles farther north (see Pl. V). Mawson's "Banzare Land" to the west is in even closer harmony with Wilkes's North's High Land and Totten's High Land, whose positions average perhaps thirty miles farther north, both figures far within the limit of error in estimating distances under Antarctic conditions.

In recapitulation after this survey of Antarctic exploration within the Australian sector, one is forced to the conclusion that the feeling against Wilkes, due to the attacks of Ross and Markham, which alone could explain the attitude toward his achievements, was largely British and so strong that a well-considered evaluation of his discoveries was hardly possible. Today a number of British authorities of the first rank, as will be seen, have shown a greater measure of justice to Wilkes. If in this article I have written with great frankness concerning this injustice on the part of some British explorers, I yield to no one in doing homage to their splendid achievements in Antarctic exploration.

[43] *New York Times*, March 20, 1931, p. 1, column 1.

Use of Name "Wilkes Land" on Early Maps

It might perhaps be expected that someone of Wilkes's own countrymen would be the first to suggest the use of "Wilkes Land" for the great coast he discovered. E. S. Balch, the well-known authority on the history of Antarctic exploration, was able to trace the use of the term "Wilkes Land" as far back only as Stieler's atlas, edition of 1866 (Antarctica, p. 164).

Thanks to the remarkable library of atlases in the possession of Professor L. C. Karpinski of the University of Michigan, I was able almost at once to trace the use of the term to 1841, which, if not its first use, must certainly be very close to it, since Wilkes did not reach Sydney, his first port of call on returning from the Antarctic, until March 11, 1840. This atlas (Allgemeiner Hand-atlas), published by the Geographisches Institut of Weimar about 1846, was one of the most authoritative of the German atlases. It contains a map of the Southern Hemisphere which is dated 1841 prepared and drawn by C. F. Weiland, upon which appears "Southern Continent" and beneath it "Wilke's Land" with an interrogation mark (Fig. 5a). A map of the Southern Hemisphere, bound within the same cover and dated 1846, differs in having the interrogation point removed from the words "Wilke's Land." In Professor Karpinski's collection there is also found the "Grosser Hand-Atlas über alle Theile der Erde in 170 Karten, herausgegeben von J. Meyer" (Verlag des Bibliographischen Instituts, Hildburghausen, 1844), which contains a map of the Southern Hemisphere of date 1844, on which "Wilke's Land" without other designation is used for the coast of the Australian sector of the Antarctic (Fig. 5b).

American atlases of the period of the 1840's and 1850's in various editions of Mitchell, Tanner, Morse, Colton, Smith, and Olney, the first-mentioned being the most widely used, without exception show the Antarctic Continent, sometimes with mention of the U. S. Exploring Expedition or of Wilkes's discoveries, but in no case making use of the expression "Wilkes Land" (Figs. 5c, 5d, 5e).[44]

It thus appears that the naming of Wilkes Land came through German sources and that American atlases made no use of it, at least through the forties, fifties, and much of the sixties of the nineteenth century. It is worth noting on the American atlases that January 19, 1840, is always given as the day when the Antarctic land was first discovered by Lieutenant Wilkes, this being the day when he saw and named Cape Hudson.

[44] This is true of Mitchell's New Universal Atlas in editions of 1847, 1849, 1854, 1862, and 1866 and of Tanner's atlas, at least in editions of 1843, 1844, and 1846; also of S. W. Morse's atlas of 1845; of Colton's General Atlas of 1850; and of Roswell T. Smith's atlas in the editions of 1843 and 1854. The writer has had access to some of these atlases either in the Library of the University of Michigan or in that of Professor L. C. Karpinski. He is indebted to Colonel Lawrence Martin, chief of the Division of Maps of the Library of Congress, for information concerning Tanner's atlases.

Wilkes's landfalls are generally ignored on the early British[45] and French[46] atlases.

Modern Practice Concerning Recognition of Wilkes Land

All the great geographic publishing houses of Germany, so far as has been observed, have recognized Wilkes Land as covering the coast throughout the fifty or more degrees of longitude within the Australian sector, as, for example, in Stieler, Andree,[47] Debes, etc. Various German authorities who have discussed Antarctic problems have illustrated them by means of maps on which Wilkes Land is included.

Dr. Karl Fricker, German authority on the Antarctic, in his valuable work "The Antarctic Regions" (London and New York, 1900) published just before the Antarctic expeditions that set out at the beginning of the present century, printed a chart of the south polar region on which Wilkes Land appeared to cover the main coast and the islands as far as Ringgold's Knoll. Dr. Georg Neumayer in his "Auf zum Südpol: 45 Jahre Wirkens zur Förderung der Erforschung der Südpolar-region 1855 bis 1900" (Berlin, 1901) printed a map with Wilkes Land which extended from 100° to 138°. Wilhelm Filchner, commander of the second German expedition to the Antarctic, in his "Zum Sechsten Erdteil" (Berlin, 1922), printed a south polar map with "Wilkes Land" across the Australian sector. Haack's wall maps, widely used by universities throughout the world, use Wilkes Land in its original sense.

In Sweden the late Dr. Otto Nordenskjöld, professor of geography at the University of Göteborg, wrote of the coasts of the Antarctic Continent: "the earliest known of these coasts, and the first of all in the Antarctic on which one was able to prove land of continental extent, is the so-called Wilkes Land, the northern coast of Victoria Land."[48]

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[45] British atlases of the 40's and 50's are of interest. Thus A. Keith Johnston in his chart of the world in The National Atlas (Edinburgh, 1844) and in its editions of 1846 and 1850 shows "Part of the Supposed Southern Continent (seen by Lieut. Wilkes of the American Navy in 1840)." The popular atlas issued also in 1840 and 1844 by the Society for Diffusion of Useful Knowledge (London) on its map No. 12 represents the Antarctic region with all English and French discoveries but without mention of the American ones by Wilkes. Teesdale in 1848 in his maps of the Eastern Hemisphere and of the world on Mercator's projection, gives "Land discovered by Capts. Ross and Crozier in 1840" but ignores Wilkes, as does also J. Arrowsmith in his atlas issued in 1852. Blackie's Imperial Atlas of 1860 likewise ignores Wilkes. Black's General Atlas of 1860 on a small map of the south polar area represents the "Antarctic Continent" with boundaries like those of Wilkes but without mention of him. Findlay's atlas of 1883 on his world maps shows the English and French discoveries but not the American. Keith Johnston, however, in his Royal Atlas of 1861 on the map "The World in Hemispheres" (p. 1) shows "Wilke's Land."

[46] French atlas practice was as follows: Andriveau-Goujon in the atlas of 1843, and in the large atlas of 1859 (Atlas classique et universel de géographie ancienne et moderne, Paris) mentions neither Ross nor Wilkes. Delamarche in his atlas of 1846 shows in the world map in two hemispheres "Terre Victoria" but no mention of Wilkes or his discoveries.

[47] The latest edition of Andree follows Mawson in the restricted use of the term.

[48] Die Polarwelt, Berlin, 1909, p. 79.

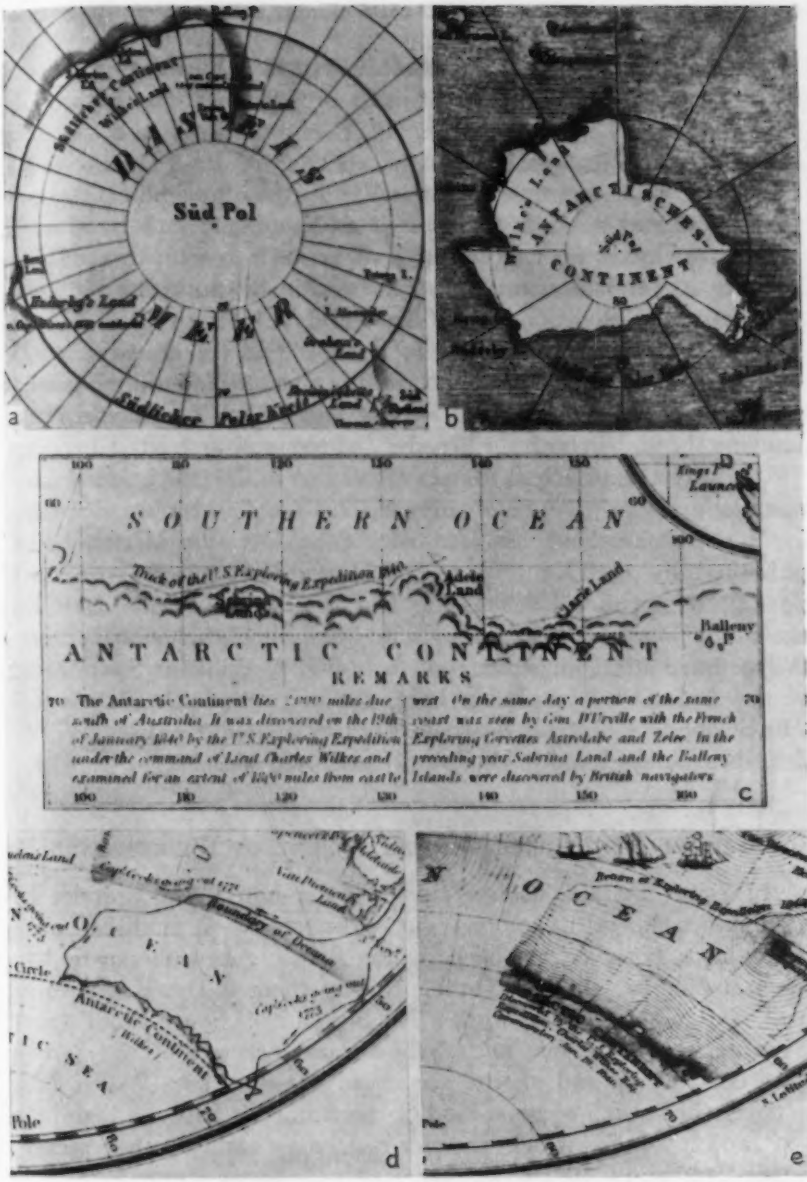

Süd Pol
a
ANTARCTISCHES
CONTINENT
b
SOUTHERN OCEAN
Track of the U.S. Exploring Expedition 1840
Adelie Land
Victoria Land
Balleny
ANTARCTIC CONTINENT
REMARKS
The Antarctic Continent lies 2000 miles due south of Australia. It was discovered on the 19th of January 1840 by the U.S. Exploring Expedition under the command of Lieut Charles Wilkes and examined for an extent of 1500 miles from east to west. On the same day a portion of the same coast was seen by Com. D'Urville with the French Exploring Corvettes Astrolabe and Zelee. In the preceding year Sabrina Land and the Balleny Islands were discovered by British navigators.
c
Boundary of Dreams
Antarctic Continent
Pole
d
OCEAN
Pole
e

FIG. 5—Reproductions of portions of maps from German and American atlases of the 1840's and 1850's on which the Antarctic Continent is represented.

(a) The Southern Hemisphere, Atlas of the Geographical Institute of Weimar, dated 1841 (Library of L. C. Karpinski).

(b) The Southern Hemisphere, Meyer's Great Reference Atlas, edition of 1844 (Library of L. C. Karpinski).

(c) "The Pacific Ocean including Oceana," Mitchell's New Universal Atlas, Philadelphia, 1854. The same map is in the edition of 1852.

(d) The "World on the Globular Projection" from Mitchell's Atlas of 1854 (map dated 1850).

(e) The World on a globular projection from Olney's School Atlas of 1844, by D. F. Robinson. Published by Woodford & Co., New York. The same map is in Smith's Atlas of 1843.

The authoritative atlas in Sweden, "Nordisk Världsatlas" (Stockholm, 1926), shows Wilkes Land in its broader meaning, both on the land and water hemisphere maps (Pl. 1) and on the map of the Polar Regions by Professor Nordenskjöld (Pl. 37). In a small Swedish atlas just issued, however (Svensk Världsatlas, Stockholm, 1930, Pl. 7), Wilkes Land is shown in the restricted meaning given it by Mawson.

In Norway, so far as known, the practice is general to use Wilkes Land in its original meaning.[49] Skattum in his authoritative report on Antarctic exploration uses Wilkes Land on his map for the Australian sector of the Antarctic.[50] In his new two-volume work on the history of Antarctic exploration[51], Bjarne Aagaard follows the practice of the American Geographical Society (see below) by placing Wilkes Land on the map in both the broader and the more restricted meanings.

In Italy the principal atlases appear to follow the general continental European practice of using Wilkes Land in its broader meaning.[52] In Switzerland the "Atlas für Schweizerische Mittelschulen" published by the Kantonale Erziehungsdirectoren in editions of 1911 and 1915 shows Wilkes Land in the broad sense. In Holland the south polar chart of Beekman and Schuiling's school atlas shows Wilkes Land stretching from 100° to 145° E.[53] While no Spanish map of the Antarctic is available here, the great Spanish encyclopedia "Enciclopedia Universal Ilustrada" (1930), under the title "Wilkes" describes Wilkes Land in the usually accepted sense.

British Authorities Who Favor Use of Wilkes Land

In Great Britain, as has already been noted, the practice has been rather general to ignore Wilkes's discoveries on published maps. There have, however, not been lacking British geographers who have taken a different stand. Notable among them is Dr. Hugh Robert Mill, who in his standard work "The Siege of the South Pole" (1905) gives an eminently fair and well-balanced account of the Wilkes-Ross controversy and on the accompanying map uses Wilkes Land to cover the stretch of coast land of the Antarctic between longitudes 130° and 150° E., which therefore includes among other sections Adélie Land and Côte Clarie. Dr. R. N. Rudmose Brown, Antarctic explorer and professor of geography at the University of Sheffield, in his work "The Polar Regions" says, after a discussion of the Australian sector of the Antarctic, "Most suitably this part of Ant-

[49] For example, Ivar Refsdal: Skole-atlas, Oslo, 1925.

[50] O. J. Skattum: Sydpolforskning, *Norske Geogr. Selskabs Aarbok*, Vol. 22, 1910–11, pp. 1–120.

[51] Bjarne Aagaard: Fangst og Forskning I Sydishavet, Oslo, 1930.

[52] "Grande Atlante Geografico," 3rd edit., Novara, 1927; "Atlante Internazionale del Touring Club Italiano," 3rd edit., Milan, 1929, Pl. 3. However, the "Atlante Universale" of the Istituto Italiano d'Arte Grafiche (Bergamo, 1927) on Pl. 72 uses Wilkes Land in accord with the usage of Mawson.

[53] Schoolatlas van de geheele aarde door A. A. Beekman en R. Schuiling, Zutphen, 1894.

arctica is generally known as Wilkes Land, although strictly speaking the name was confined by Mawson to the coastline immediately west of Adelie Land."[54]

Dr. Griffith Taylor, Australian geologist on Scott's last expedition and now professor of geography at the University of Chicago, speaks in the highest terms of the character of Wilkes's work but omits the discovery of Cape Hudson on January 19, 1840, and makes the landfall of January 23 the first of Wilkes's on the Antarctic Continent. He says, "Wilkes' fine voyage with ill-found ships apparently *along the coast* most of the way from longitude 148° E. to 108° E. is an achievement which has not yet been repeated." He concludes, however, "As to whether the name, Wilkes Land, is to be given to all this coast or to the restricted area (in 134° E.) mapped on Mawson's expedition and by him named Wilkes Land, it is difficult to decide."[55]

Sir John Scott Keltie, while secretary of the Royal Geographical Society, published in the London *Graphic* (August 10, 1901) an Antarctic map with the Wilkes Land coast represented and labeled. J. G. Bartholomew of Edinburgh and A. J. Herbertson of Oxford in their "Atlas of Meteorology" (London, 1899) include Wilkes Land in its broad sense, and this is characteristic of certain other atlases by Bartholomew and the maps accompanying the history of oceanography by Sir John Murray serving as an introduction to the "Summary of Scientific Results" (1895) of the Challenger Expedition reports.

French Practice

French geographers have rather generally followed the English tradition and have ignored American discoveries in the Australian sector of the Antarctic, inserting, however, those of British or French origin. Dr. Charcot, the distinguished explorer in West Antarctica, has been no exception to this general rule. Maurice Zimmerman in his "Régions polaires australes" prints a map of the Antarctic which includes Wilkes Land (Terre de Wilkes) in the sense given it by Mawson.[56] Vivien de Saint-Martin, in his "Histoire de la géographie et des découvertes géographiques" (Paris, 1873), prints on his atlas a map on which "Terre de Wilkes" is used for a restricted section of the coast, Knox Land of Wilkes, one of his landfalls in western Wilkes Land.

One French voice has been raised in defense of Wilkes. This was early in 1856 when Laugel wrote:[57]

[54] The Polar Regions: A Physical and Economic Geography of the Arctic and Antarctic, London, 1927, p. 25.

[55] Antarctic Adventure and Research, New York, 1930, pp. 28–29.

[56] Géographie Universelle, Vol. 10, Paris, 1930, pp. 285–351; reference on p. 297.

[57] A. Laugel: Le pôle austral et les expéditions antarctiques, *Rev. des Deux Mondes*, Vol. 26, 2nd period, 1856, p. 818.

The suspicion of the English navigator (Ross) went even to injustice and I could not wish for better proof than the perfect coincidence of the contours of Adélie Land of Dumont D'Urville and the same coast traced by Wilkes. Sir James Ross could not have failed to be struck by this accord. All the indications of Wilkes between the 150th and the 100th degree have such a character of precision that they do not appear to lead to any uncertainty, and even in taking account of the curious errors which marked the start of his voyage, it leaves to Wilkes a part fine enough.

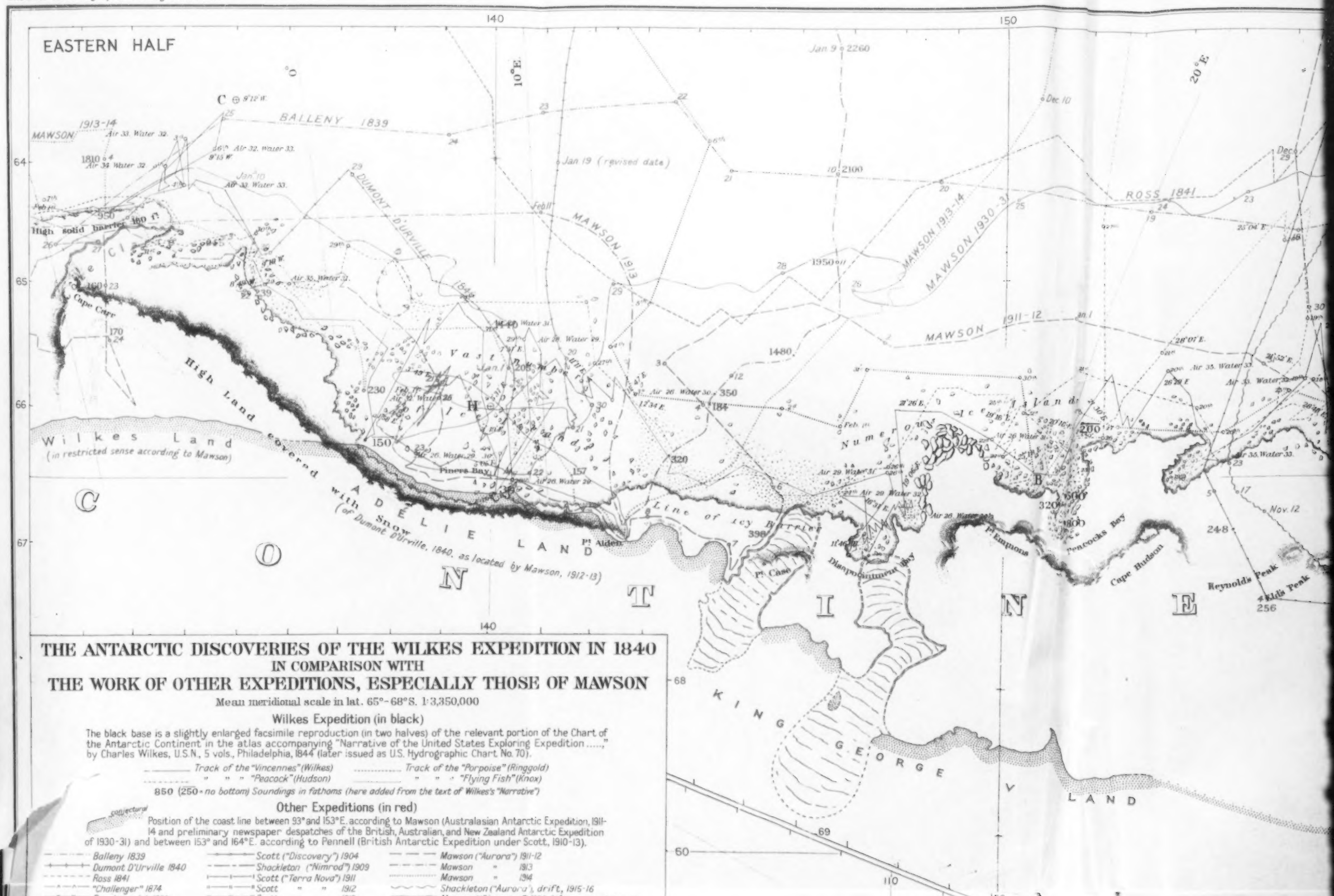
The American Geographical Society and Wilkes Land

Though American practice was slow to notice the use of Wilkes Land abroad, yet in later years it has been general to enter Wilkes Land on American maps of the Antarctic. On its "South Polar Chart," 1:40,000,000, summarizing the status of knowledge in 1905, the American Geographical Society applied the name Wilkes Land to the whole continental margin from Ringgold's Knoll to Knox's High Land (160°–105° E.). In its new standard large four-sheet Map of the Antarctic on the scale of 1 : 4,000,000, published in 1928 (and its derivatives in 1 : 12,500,000 and 1 : 20,000,000), the American Geographical Society has placed Wilkes Land on its maps in both the original and Mawson senses—in the former on the sector between 133° E. and 100° E., which is marked "based upon Wilkes' recognition of the existence of a continent," in the latter on the stretch between 135° and 131°, which is accompanied by the statement "Wilkes Land in restricted sense, according to Mawson."[58]

The position of the Society with regard to the new landfalls by Mawson in 1930–1931 and their bearing on Wilkes's discoveries is thus defined:

The positions of the sections of coast in longitudes 126°, 122°, 116°, and 107°, as reported by Mawson [from his 1930–1931 expedition], when superimposed on a map showing the position of the edge of the Antarctic Continent as laid down by Lieutenant Charles Wilkes, U. S. N., on his expedition in 1840 and designated respectively North Land, Totten Land, Budd Land, and Knox Land, agree remarkably with Wilkes's outline. In general, Mawson's land positions lie somewhat farther inland than Wilkes's, but even Wilkes's implied embayments are reflected in the advanced and receded positions of Mawson's coastal stretches. When the conditions under which Wilkes operated are borne in mind, it is quite understandable that he may often have mistaken the edge of the solid pack or grounded icebergs for the real edge of the land, as was actually the case at the eastern and western end of Wilkes's explorations in this sector, where it was Mawson himself who sailed over some of Wilkes's landfalls. Nevertheless, as has been pointed out in "Prob-

[58] "In this sense Wilkes Land extends through about four degrees of longitude (131°–135° E.). This contrasts with the use of the term as applying to a stretch of coast extending through about sixty-five degrees of longitude (95°–160° E.) and comprising the range of discoveries of (then) Lieutenant Charles Wilkes, U. S. N., in 1840, which he himself interpreted and announced as constituting the margin of the Antarctic Continent. Although some of his landfalls, especially toward the east, have proved to be non-existent and although it is probable that he sometimes mistook for land the northern edge of the shelf ice and the solid pack with icebergs embedded in it, it is indisputable that he first outlined in their continuity, and recognized as such, the phenomena of a continental margin for a distance of 1800 miles.—Edit. Note" (Problems of Polar Research, *Amer. Geogr. Soc. Special Publ. No.* 7, 1928, p. 254).



THE ANTARCTIC DISCOVERIES OF THE WILKES EXPEDITION IN 1840
IN COMPARISON WITH
THE WORK OF OTHER EXPEDITIONS, ESPECIALLY THOSE OF MAWSON

Mean meridional scale in lat. 65°-68°S. 1:3,350,000

Wilkes Expedition (in black)

The black base is a slightly enlarged facsimile reproduction (in two halves) of the relevant portion of the Chart of the Antarctic Continent in the atlas accompanying "Narrative of the United States Exploring Expedition ....." by Charles Wilkes, U.S.N., 5 vols., Philadelphia, 1844 (later issued as U.S. Hydrographic Chart No. 70).

——— Track of the "Vincennes" (Wilkes) ..... Track of the "Porpoise" (Ringgold)
– – – – " " " "Peacock" (Hudson) ..... " " " "Flying Fish" (Knox)

850 (250 = no bottom) Soundings in fathoms (here added from the text of Wilkes's "Narrative")

Other Expeditions (in red)

conjectural

Position of the coast line between 93° and 153°E. according to Mawson (Australasian Antarctic Expedition, 1911-14 and preliminary newspaper despatches of the British, Australian, and New Zealand Antarctic Expedition of 1930-31) and between 153° and 164°E. according to Pennell (British Antarctic Expedition under Scott, 1910-13).

- Balleny 1839
- Dumont D'Urville 1840
- Ross 1841
- "Challenger" 1874
- Borchgrevink 1899
- Drygalski 1902
- Scott ("Discovery") 1904
- Shackleton ("Nimrod") 1909
- Scott ("Terra Nova") 1911
- Scott " " 1912
- Scott " " 1913
- Mawson ("Aurora") 1911-12
- Mawson " 1913
- Mawson " 1914
- Shackleton ("Aurora"), drift, 1915-16
- Mawson ("Discovery") 1930-31, course and length of flights approximate only)

Balleny 1839
Dumont D'Urville 1840
Ross 1841
"Challenger" 1874
Borchgrevink 1899
Drygalski 1902
Scott ("Discovery") 1904
Shackleton ("Nimrod") 1909
Scott ("Terra Nova") 1911
Scott " " 1912
Scott " " 1913
Mawson ("Aurora") 1911-12
Mawson " 1913
Mawson " 1914
Shackleton ("Aurora"), drift, 1915-16
Mawson ("Discovery") 1930-31 (course and length of flights approximate only)
Flights
1810 Soundings in fathoms

WESTERN HALF

DRYGALSKI 1902
Cook in 1773
"CHALLENGER" 1874
MAWSON 10°W 1911-12
50°W
Line of Icy Barrier
Numerous Ice Islands along this Barrier
BALLENY 1839
MAWSON 1913-14
MAWSON 1913
MAWSON 1930-31
MAWSON 1911-12
Numerous Ice Islands
Repulse Bay
Termination Land
Termination Tongue (no longer in existence 1931)
Bowman I.
Knox's High Land
Budd's High Land
Sabrina Ld
(Balleny's landfall of 1839)
Davis Sea
ANTARCTA
QUEEN MARY LAND

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150
160
170
20° E
30° E
Jan 9
Dec 10
Dec 29
Feb 1
Jan 1
Dec 12
ROSS 1841
MAWSON 1913-14
MAWSON 1930-31
MAWSON 1911-12
SCOTT 1904
SCOTT 1912
SCOTT 1913
SCOTT 1911
SHACKLETON 1915-16
SHACKLETON 1909
BORCHGREVINK 1899
Air 34 Water 32
Air 32. Water 32.
Air 35. Water 33.
Air 33. Water 30.
Air 34 Water 30
Air 37 Water 31.
Air 29 Water 31
Air 29 Water 32
Air 26 Water 30
Numerous Icebergs
Line of Icy Barrier
Land as indicated on Ross's published copy of the tracing of Wilkes's MS chart sent to Ross by Wilkes in New Zealand, April, 1840
Young I.
Buckle I.
Sturge I.
BALLENY ISLANDS
Ringgold's Knoll
Reynolds Peak
Kidd's Peak
Pt Empress
Peacocks Bay
Cape Hudson
Pt Case
Disappointment Bay
KING GEORGE V LAND
OATES
March 1
March 15
Feb 3
Feb 6
Jan 30
Sept. 22
Nov. 12
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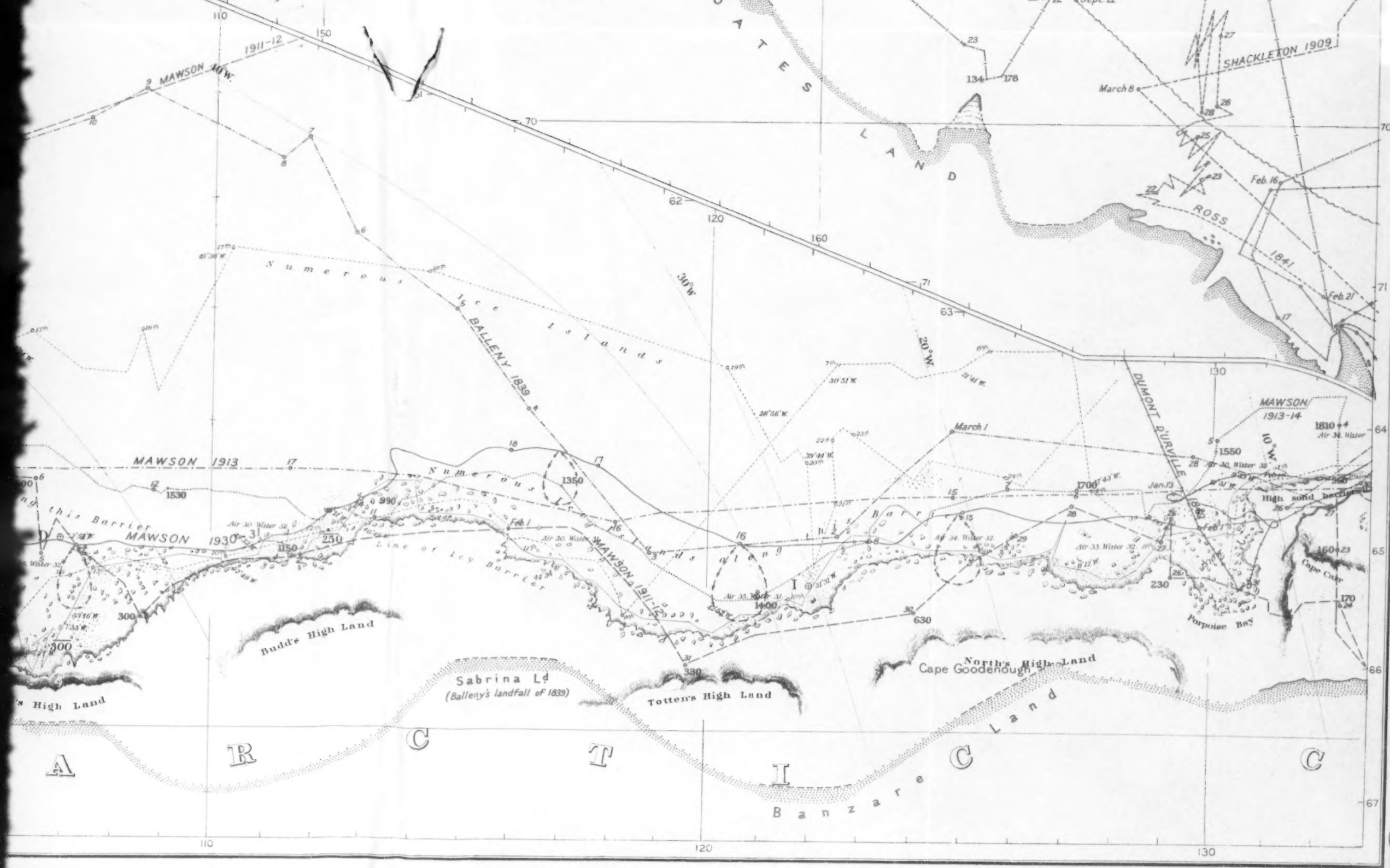
110
150
1911-12



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lems of Polar Research" (*Amer. Geogr. Soc. Special Publ. No. 7*, editorial footnote on page 254), it would seem a fair interpretation of Wilkes's work to say that he first outlined in their continuity the phenomena of a continental margin in this sector for a distance of 1800 miles. This interpretation is all the more justified by the fact that he himself saw the general bearing of his discoveries and was the first to recognize that the features he had observed define a land mass of continental proportions.[59]

The usage of Wilkes Land in two senses is, of course, a temporary expedient. It was introduced to place the matter squarely before students of the question, pending settlement. Now, the knowledge gained by Mawson's expedition of 1930–1931 together with the points discussed in this paper will, it is hoped, point the way to a satisfactory solution.

Note on the Map, Plate V

The map is intended to afford a comparison between the discoveries of Wilkes and those of his contemporaries and successors in the same area. To that end Wilkes's chart is reproduced, somewhat enlarged and divided into two parts for reasons of space, in facsimile as the black base. Superimposed on this chart, which is on Mercator's projection, are the routes of other explorers. The tracks of the vessels are taken from the maps accompanying the publications cited above in footnotes thus: Balleny, 16; d'Urville, 5; Ross, 18; Challenger Expedition, 39; Borchgrevink, 29; Drygalski, 40; Scott, 31 and 38; Shackleton, 37; Mawson, 36 and 4.

In addition use has been made of "Chart of Victoria Land, Latitude 66° S. to 80° S., Longitude 160° E. to 180° E., Shewing Tracks of Vessels and Discoveries to 1900, 1:3,500,000," accompanying Louis Bernacchi: To the South Polar Regions: Expedition of 1898–1900, London, 1901, and "Map of the Ross Sea Sector of the Antarctic, 1:3,000,000," in F. Debenham: Report on the Maps and Surveys (Scientific Results British (Terra Nova) Antarctic Expedition), London, 1923, Map I.

The detail of the courses is not equal: in some instances, most notably the maps of Ross (1 : 24,000,000) and Mawson (1 : 30,000,000) the scale of the source map is considerably smaller than that of Plate V.

[59] *Geogr. Rev.*, Vol. 21, 1931, p. 327.

ROCK PLANES OF ARID REGIONS

Douglas Johnson
Columbia University

AMONG the most characteristic elements of the arid landscape are far-spreading lowland plains which incline gently away from the larger mountain masses. In 1897 McGee[1] demonstrated that such surfaces in the southwestern United States and northern Mexico consisted in part of remarkably smooth rock planes. He attributed them to the erosive action of "sheet floods," vast expanses of moving water formed when a flooded canyon discharged upon the lowland, or when very heavy rains fell directly upon its nearly level surface. To a typical example he applied the term "pediment." American writers have often followed McGee in speaking of these rock planes as "pediments," although few have accepted his theory of their origin.

Other investigators, both in America and abroad, have sought to explain these rock planes as a product of wind erosion or deflation.[2] Lawson[3] advanced the theory that such a plane could be produced by progressive retreat of the adjacent mountain front due to weathering processes alone, especially rock disintegration under the influence of insolation. Bryan,[4] Davis,[5] and others have to a large extent followed Lawson, although both attribute minor rôles to lateral planation by streams.

The Theory of Stream Planation

For some years the writer has been developing and testing a theory of pediment formation, based on an early suggestion by Gilbert.[6] The essence of this theory is that rock planes of arid regions are not the product of sheet-flood erosion, nor of wind erosion, nor of mountain-front retreat by weathering, *but of normal stream erosion.* A peculiarity of the stream erosion theory is the relative importance attached to lateral corrasion. This results from the fact that heavily

[1] W J McGee: Sheetflood Erosion, *Bull. Geol. Soc. of America*, Vol. 8, 1897, pp. 87–112.

[2] See for example a long list of titles by Charles R. Keyes.

[3] Andrew C. Lawson: The Epigene Profiles of the Desert, *Univ. of California Publs. in Geol.*, Vol. 9, 1915–1916, pp. 23–48.

[4] Kirk Bryan: Erosion and Sedimentation in the Papago Country, Arizona, *U. S. Geol. Survey Bull. 730*, 1922, pp. 19–90.

[5] W. M. Davis: Rock Floors in Arid and in Humid Climates, *Journ. of Geol.*, Vol. 38, 1930, pp. 1–27 and 136–158.

[6] G. K. Gilbert: Report on the Geology of the Henry Mountains (U. S. Geogr. and Geol. Survey of the Rocky Mountain Region), Washington, 1880.

laden streams of arid regions are not able to cut vertically downward to the same extent as are the relatively less burdened streams of humid areas. Hence the consequences of lateral migration, always taking place in every stream of running water, are more conspicuously in evidence. For this reason one may properly speak of this conception of pediment origin as the theory of lateral corrasion, or lateral planation; although it should not be forgotten that the essence of

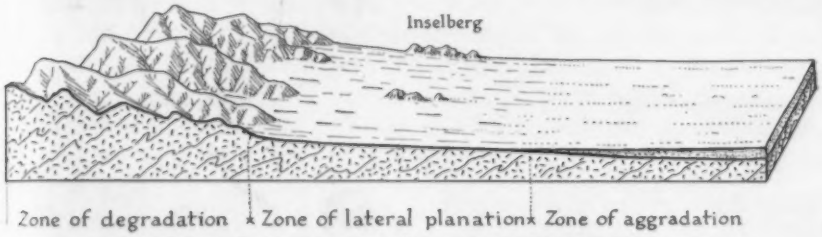


FIG. 1—Zonal arrangement of stream action in arid regions.

the theory lies in the broader conception that rock planes of arid regions are the product of stream erosion rather than in any particular belief as to the relative proportions of lateral and vertical corrasion.

In 1931 the writer outlined his theory of the origin of rock planes.[7] The substance of the theory may briefly be re-stated as follows:

Every stream is, in all its parts, engaged in the three processes of (a) vertical downcutting or degrading, (b) upbuilding or aggrading, and (c) lateral cutting or planation. Under different conditions one or another of these processes may become more important, and the other two operate less vigorously or intermittently. If we imagine an isolated mountain mass in an arid region (Fig. 1), it will be evident that the gathering ground of streams in the mountains, where greater precipitation occurs, will normally be the region where vertical cutting is at its maximum. Aggradation will be intermittent, local, and temporary. Lateral cutting will be vigorous, and for every hundred feet of downcutting two or more hundred feet of lateral movement of the stream may take place. But even so the deepening process keeps the valleys youthful in character, with narrow bottoms and relatively steep sides. Valley deepening appears dominant, even if it be actually subordinate to lateral corrasion.

Far out from the mountain mass conditions are reversed. Each stream must distribute its water and its load over an ever-widening sector of country. The water disappears, whether by evaporation or by sinking into the accumulating alluvium. Aggradation is at its maximum, and vertical downcutting is intermittent in character and both local and limited in extent. Lateral corrasion may be dominant in fact, the streams shifting hundreds or thousands of feet laterally

[7] Douglas Johnson: Planes of Lateral Corrasion, *Science*, Vol. 73, 1931, pp. 174–177.

for every hundred feet of upbuilding. But the observer is impressed by the ever-thickening mantle of alluvium: aggradation appears dominant, even if it be actually subordinate to lateral corrasion.

Between the mountainous region of apparently dominant degradation and the distant region of apparently dominant aggradation there must be a belt or zone where the streams are essentially at grade.

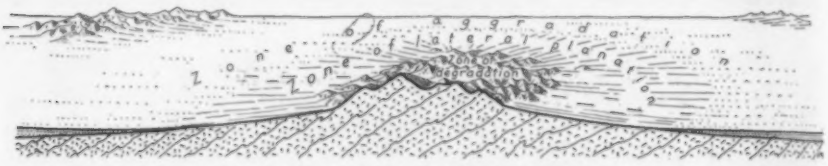


FIG. 2—Concentric zones of the ideal desert range.

Both downcutting and upbuilding are at a minimum, while lateral corrasion is again dominant not only in fact but also in appearance. Since the dominant lateral cutting takes place essentially at a constant level, its results are strikingly obvious. Interstream areas are consumed, and the valley bottoms coalesce to give a single rock plane sloping in all directions away from the central mountain mass. On this plane the thin veneer of alluvium left by the shifting streams will remain until weathering, sheet floods, and wind have disintegrated and removed everything down to bed rock.

About each desert range there should then normally be found three concentric zones (Fig. 2) in all of which lateral corrasion is actually dominant but in each of which the three processes of degradation, corrasion, and aggradation assume such strikingly different relations that each zone in turn appears to be dominated by a different process. Thus from the center outward are (1) the *zone of degradation*, (2) the *zone of lateral corrasion*, (3) the *zone of aggradation*. Heavily laden streams issuing from the mountainous zone of degradation are from time to time deflected against the mountain front. This action, combined with the removal of peripheral portions of interstream divides by lateral corrasion just within the valley mouths, insures a gradual recession of the face or faces of the range. Such recession will be aided by weathering as well as by rain and rill wash; but it must occur even were these processes of negligible importance. The three zones thus progressively contract, providing a beautifully adjusted mechanism which insures that at every point within the initial mountain mass streams will ultimately be maintained at a given level in the balanced or graded condition until the work of planation is complete.

ROCK FANS

While the writer was engaged in deducing the reasonable consequences of the foregoing theory of pediment origin, he came upon

a wholly unanticipated result. On purely theoretical grounds it appeared that, if the pediment be a product of stream erosion and the mountain front retreats mainly through trimming of its frontal spurs as the shifting streams from time to time impinge against them, the zone where plane and mountain meet should exhibit a series of relatively flat semi-cones, or less than semi-cones. Each partial cone would appear to be an ordinary alluvial fan where deposition of débris was plentiful; but in the absence of such débris it should be a bed-rock surface having the form of a typical fan and apexing like the alluvial fan at the mouth of the canyon from which issued the sculpturing stream (Fig. 3). That this must be the case will be evident to anyone who will visualize the geometric form described by an inclined stream relatively (but not rigidly) fixed in position at the point of issuance from the canyon mouth and shifting more and more widely below that point. The alluvial fan is the expression of that form where deposition alone has occurred or where considerable deposition has accompanied erosion of bed rock. The "rock fan," as I have called it, is the same form where retreat of a mountain front has let streams operate on the solid mass of the range and where erosion has exceeded deposition.

Field search revealed the existence of such "rock fans" in a number of localities, and the finding of these forms, following the purely deductive conclusion that they ought to exist, inevitably inspired an added measure of confidence in the theory that rock pediments, or suballuvial benches, owe their development chiefly to the corrading action of heavily laden, frequently shifting streams. A full discussion of these highly interesting forms, and of their relation to the problem of desert rock planes, was recently published.[8]

Braided and Swinging Streams

There are certain considerations implicit in the theory of planation by stream erosion which should perhaps be specified to avoid misunderstanding, especially since the oversimple statements of my earlier papers have led to some misconception as to what the theory involves. It must be realized, for example, that the drainage conditions of arid regions described in the text and pictured in Figures 1 and 2 imply extensive braiding, or anastomosing, of streams. It should not be inferred that master streams issuing from mountain canyons continue across either alluvial fans or rock fans and pediments with their integrity unimpaired. Heavily laden streams in arid regions, losing water by evaporation and by infiltration into alluvium, behave quite differently. They divide and subdivide

[8] Douglas Johnson: Rock Fans of Arid Regions, *Amer. Journ. of Sci.*, Ser. 4, Vol. 23, 1932, pp. 389–416.

indefinitely (Fig. 4), the minor channels reuniting and interlacing and frequently shifting both their positions and their connections.

Rarely is the observer fortunate enough to see the stream at work. Ordinarily he beholds only a network of dry, broad, shallow channels, each filled with sand, gravel, or boulders. These may lie

FIG. 3—Rock fan, eroded on granite at eastern base of Sierrita Mountains, Arizona. The negative was retouched to emphasize outline of the fan, but the view correctly represents the essential relations.

near the surface of the rock plane, and offer so little evidence of stream erosion that the observer discounts their importance. Only when seen from some neighboring height or from an airplane, does the vast network of interlacing stream lines appear impressive.

The irregular "swinging" of heavily laden streams in arid regions should not be confused with the systematic lateral and down-valley migration of meanders. Both processes involve lateral planation; but a stream embarrassed by a heavy load is not free to swing in symmetrical serpentine curves. Accumulation of débris tends to block the channel, the stream spreads, cross currents are set up, and braiding develops rather than meandering. The heavy load favors lateral planation at a given horizon not only by preventing vertical incision of the stream but also by favoring its lateral displacement through accumulation of débris along and within the channel. Since there are a multitude of interlacing channels, no one of them need shift very far in order that lateral planation should take place over the entire surface of fan or pediment.

PIEDMONT DEPRESSIONS

A master stream debouching from a canyon mouth upon its alluvial fan may descend first one radius of the fan, then another,

and so on; or it may split and descend several radii simultaneously. It has been observed that a favorite location is along the inner borders of the fan, where the latter makes contact with the mountain wall. Streams very commonly occupy these marginal positions, even when the master stream from the canyon descends the central portion of

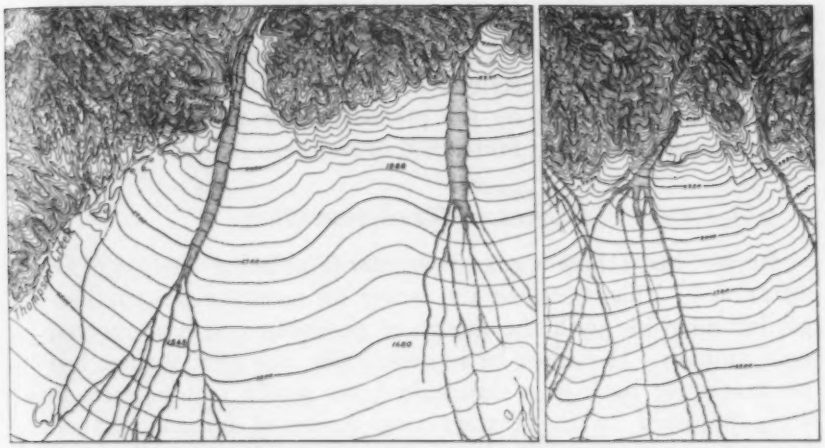


FIG. 4—Alluvial fans of the Cucamonga region, California, showing braided channels. Note on the left the depression followed by Thompson Creek. Scale approximately 2 miles to the inch. (From U. S. G. S. topographic sheet, Cucamonga Quadrangle.)

the fan. If the reader will examine portions of the Cucamonga (California) topographic quadrangle (Fig. 4), he may better appreciate both the fact and its explanation. Streams from minor canyons and still smaller ravines, debouching upon the sides of the fan, encounter the pronounced slope graded by the master stream. They turn abruptly along the mountain base and follow down this slope. There is thus assured a marginal channel, into which the master stream may itself debouch at times. Thompson Creek (Fig. 4, left) occupies such a depression on a fan where the master stream descends one of the more central radii; the master stream from Day Canyon (Fig. 4, right) itself descends a marginal depression. It should be noted that these marginal streams are forced into a position where trimming back of the mountain front by their lateral swinging must be peculiarly effective.

Analysis shows that the relations just observed on alluvial fans should likewise exist on rock fans carved by lateral planation of heavily laden streams. Field investigations demonstrate that marginal channels are a characteristic feature of rock fans.[9] Both the northern and southern inner margins of the rock fan shown in Figure 3 are trenched by ravines, that shown on the south (left of view) being particularly effective in trimming back the mountain spurs. Where

[9] *Ibid.*

rock fans at the inner borders of pediments are deeply eroded, the marginal streams along the mountain base play an important rôle in the process of dissection and often give rise to major "piedmont depressions" separating the mountain wall from undestroyed remnants of former rock fans and pediment. Whether this is the same feature as the piedmont depression described by Passarge[10] from Africa, the writer cannot say, as he is not familiar with the regions studied by that author. But in general it appears that the rock planes and inselberge described by Passarge and others are similar to the forms attributed by the present writer to stream erosion in the southwestern United States and in southern Africa.

Slopes of Transportation

Bryan[11] and others speak of pediments as being "slopes of transportation." This seems to the writer an accurate designation but one incompatible with the theory of pediment origin supported by these authors. It cannot be supposed that the rock surface left by the *weathering* back of a mountain front would just happen to be nicely adjusted to the transporting power of streams traversing that surface. Even were such supposition possible, the pediment slope close to the mountain front, if there adjusted to stream transport, could not be adjusted to the very different conditions of stream transport that must exist after further mountain retreat has left that part of the pediment far out in front of the range.

In most cases a pediment left by simple weathering back of the mountain front will presumably be either too gently sloping or too steep to be in perfect equilibrium with stream transport of débris. In the former case streams will deposit until equilibrium is established, and we shall have an alluvial plain, not a pediment. In the latter case streams will entrench themselves until equilibrium is reached, then open out a new plane; and we shall have a pediment determined by stream erosion at the lower level, not a pediment due to retreat of the mountain front by weathering.

Regraded Rock Planes

According to the theory of pediment origin here advanced, the pediment when first formed is truly a "slope of transportation," in perfect equilibrium with the heavily laden streams traversing it because carved by those streams. If conditions of transport vary gradually, the rock plane is slowly regraded to maintain the necessary equilibrium. This is the normal case and explains the fact observed by Bryan, that pediments in the southwestern United States com-

[10] Siegfried Passarge: Panoramen Afrikanischer Inselberglandschaften, Berlin, 1928, pp. 6-9.
[11] Bryan, *op. cit.*

monly have a slope of 200 feet to the mile close to the mountain front but only 50 feet to the mile farther out. Regrading of the rock plane A′ A″ in Figure 5, to give the rock plane B′ B″ at a lower level, is the only manner known to the writer by which the relation of pediment slopes described by Bryan can be maintained as the mountain front retreats from A to B. The slope of 200 feet per mile at A′, close to the mountain scarp, must be changed to 50 feet per mile in the

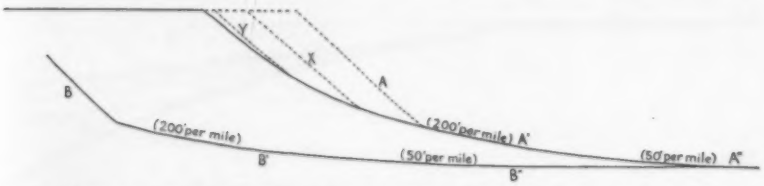


FIG. 5—Mountain-front retreat and pediment formation by weathering (AA′A″) and by stream erosion (BB′B″).

same locality (B″) by the time the mountain front has reached B. As both slopes must be bed-rock surfaces, and both must be adjusted to stream transport under the different conditions existing at A′ and B″, stream erosion appears to be the only agent competent to effect the change.

COMPARISON OF THEORIES

Such regrading by stream erosion disposes of a difficulty that seemingly confronts the theory of mountain-front retreat by weathering. If we accept as normal the slope relations described by Bryan, viz., a rock surface growing progressively steeper toward the mountain base; and if we imagine the mountain front to retreat in such manner as to let the residual rock surface grow ever steeper (as we must do if we are to maintain the prescribed relation without regrading), then we encounter the difficulty that mountain-front retreat is limited to a relatively narrow zone. For, as the front retreats from A to X (Fig. 5), the steepening pediment slope must more closely approach the angle of slope of the mountain front. This latter, according to the theory of weathering, is a relatively fixed quantity determined by size of spalls detached by insolation and other weathering agents. At Y the mountain-front slope and the pediment slope nearly coincide, and further appreciable retreat is precluded. Thus the retreat of a mountain front into the center of a broad range would appear to be impossible, and pediment slopes far steeper than those described by Bryan should commonly be reported. Neither of these deduced consequences of the weathering hypothesis corresponds with the facts noted in the field.

Lawson inferred mountain-front retreat by weathering under conditions that would leave a pediment, or "suballuvial bench"

as he called it, with surface convex upward (Fig. 6). Here we encounter the difficulty that mountain-front retreat would carry the pediment to the top of a broad mountain mass or plateau, a possibility specifically envisaged by Lawson but not represented by any case in nature so far as known to the writer. Nor does the convex surface appear nearly so characteristic of pediments as the concave form. Furthermore, Lawson's theory calls for an alluvial embankment

FIG. 6—Mountain-front retreat by weathering to give a pediment convex upward (after Lawson).

overlapping the rock surface to meet the base of the mountain scarp, unless the rock be laid bare by certain abnormal conditions specified by him. According to the writer's observations, the existence of a zone several miles broad, in which bed rock is abundantly exposed at the surface and the alluvium is restricted to a thin and discontinuous veneer of recent stream deposits, is quite as normal a feature as the more deeply buried pediment. Lawson recognized that under certain conditions of weathering the resulting rock plane might be concave upward or a straight slope; but he does not fully analyze these possibilities. We have already seen what difficulties the weathering theory encounters in the case of concave surfaces (Fig. 5). If we assume such retreat as would give a straight or uniform slope, we may either imagine the encroaching alluvial cover to lag behind

FIG. 7—Mountain-front retreat by weathering to give a pediment of uniform slope.

the retreating scarp, leaving a zone of pediment exposed as shown in Figure 7; or we may imagine the alluvial embankment to reach to the mountain base, as in Figure 6. In either case the possible extent of mountain-front retreat is limited, and the assumed relations of pediment slope to mountain front and to alluvial slope are not those most commonly observed in the field.

If the writer correctly visualizes the problem, it is not possible to represent successive profiles of mountain-front retreat in combination

with *a single lengthening but unaltered profile* of the associated pediment, as is done in Figures 6 and 7 and in the upper part of Figure 5. As the mountain front retreats the pediment is progressively regraded and hence must be represented by *a succession of profiles*, as in Figure 8. The rock plane of the pediment grades imperceptibly into the alluvial plain farther out from the mountain, and both are normally in nice adjustment with the streams traversing them. Regrading can,

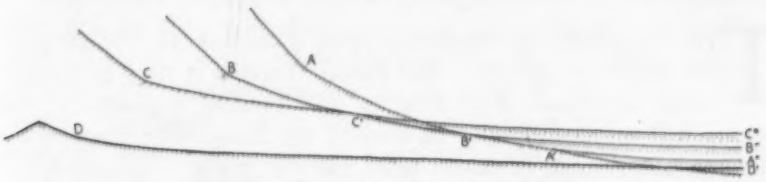


FIG. 8—Successive profiles of regraded pediments.

as shown in Figure 8, result in a certain convexity of the bed-rock surface (CC′ B′ A′) which may explain the well records accepted by Bryan as confirmation of the Lawsonian hypothesis (Fig. 6).

Regrading not only permits mountain-front retreat into the heart of broad ranges but permits lowering of both mountain front and pediment deep within the original mass, as shown at D, Figure 8. It may also involve, as revealed by profile DD′, broadening of the pediment zone in both directions, away from the mountain front as well as toward it, and the planation of older alluvium to give what is really a "pediment" erosion surface beveling the sands and gravels at a slight angle with their bedding planes. Finally, where regrading takes place suddenly, as a result of faulting, warping, change of base level, change of climate, or other competent cause, rapid stream incision followed by the development of new rock planes at successively lower levels will explain the existence of remnants of higher and intermediate rock fans and pediments that are so characteristic a feature of many arid regions.[12]

The theory of planation through erosion by heavily laden streams of arid regions satisfactorily explains so many complex relations observed about the borders of desert ranges that it seems to deserve recognition as a working hypothesis by those engaged in the study of desert morphology. Where weather and wind apparently rule today, it may prove that throughout the recent past, and perhaps even to the present time, water really has held sovereign sway.

[12] Johnson, Rock Fans of Arid Regions, pp. 394–399.

VOTING HABITS IN THE UNITED STATES

A NOTE ON TWO MAPS

John K. Wright

THE approaching election invites attention to the geography of American politics. For certain regions it may be predicted with assurance that Hoover will receive a plurality; other regions will unquestionably be carried by Roosevelt; elsewhere the outcome will remain in doubt until the returns are tabulated. The accompanying maps give a clue to the distribution of habits of voting throughout the nation.

Maps of Voting Habits

Maps showing party voting habits may be constructed on the basis of the returns of successive elections. Figures 1 and 2 were compiled from the original drawings of a series of maps of Presidential elections recently published in Dr. C. O. Paullin's "Atlas of the Historical Geography of the United States."[1] By examining the sequence of "Atlas" maps it is possible to gain a general idea of party loyalties region by region, but only with the help of composite maps of the type reproduced herewith can we compare in any detail the habitual political behavior of different communities.

Figures 1 and 2 are composites for the Presidential elections of 1876–1928 inclusive. On Figure 1 are shown the areas carried by the Republicans and by the Democrats at every election during this period. These areas are the strongholds of party conservatism. Figure 1 also shows where minor parties have met with success.

Figure 2 contrasts Republican with Democratic successes county by county. Minor parties are disregarded. The number of times each county was carried by candidates of the two chief parties was counted. The percentage of Republican successes—and conversely, therefore, of Democratic successes—was calculated with reference to this total, and this percentage was then plotted for each county.

Interpretation of the Maps

In the interpretation of these maps the reader should bear certain facts in mind. Each symbol summarizes the voting habit of a fairly

[1] See the present number of the *Geographical Review*, p. 688; also J. K. Wright, "Sections and National Growth: An Atlas of the Historical Geography of the United States," in the July number of the *Review*, pp. 353–360.

long period—for most of Figure 2 fifty-two years, including fourteen elections. Habits change. A county may have voted Democratic at one or two elections during the early part of the period and Republican ever since. One might say, therefore, that its *present* habit is to vote Republican. Figure 2, however, represents the average habit of the period 1876–1928, and this average habit is by no means necessarily the habit of the present time. Hence the map should be used with caution as a basis for prophecy. For the regions west of the Mississippi recent elections have played a larger part in shaping the pattern than is the case farther east. Large tracts in the West were unsettled or unorganized for voting purposes at the time of some of the earlier elections. Moreover, Figure 2 does somewhat less than justice to the Democratic solidarity of South Carolina, Florida, Mississippi, and Louisiana. These states were still under "carpetbag" rule at the time of the election of 1876. The Republican pluralities then recorded in some of the counties are hardly representative of the political sympathies of the white population.

The strength of political parties depends mainly on the number of votes polled. More votes are polled where population is denser, but density of population is disregarded on both maps. The concentrated Democratic strength in some of the larger cities of the Northeast is lost sight of owing to the small size of the counties in which these cities lie. Yet the city vote has often placed otherwise predominantly Republican states—Massachusetts and New York, for example—in the Democratic column in the Electoral College.

Furthermore, neither map discloses the margins by which the successful parties have won in different regions. Votes polled by minority parties do not enter the picture.

The prevailing voting habits of any region spring from a complex interplay of geographical, economic, and social forces. The patterns on the maps express differences in history, wealth, occupations, traditions, and to some degree in the power of party leaders. To explain the details of these patterns at all adequately would require prolonged study of local history. Although no such explanation can be attempted here, a few salient points may be mentioned.

The Eastern and the Western United States

In the geography of party politics there is a pronounced difference between the eastern and western halves of the country. On the eastern portion of Figure 2 the presence of areas of definite and enduring party allegiance is plainly revealed by the sharp contrasts in the shades. The late Professor F. J. Turner wrote that "there are both interstate and intrastate party areas persisting in some cases for many decades or even generations and having clear relations to natural geographic

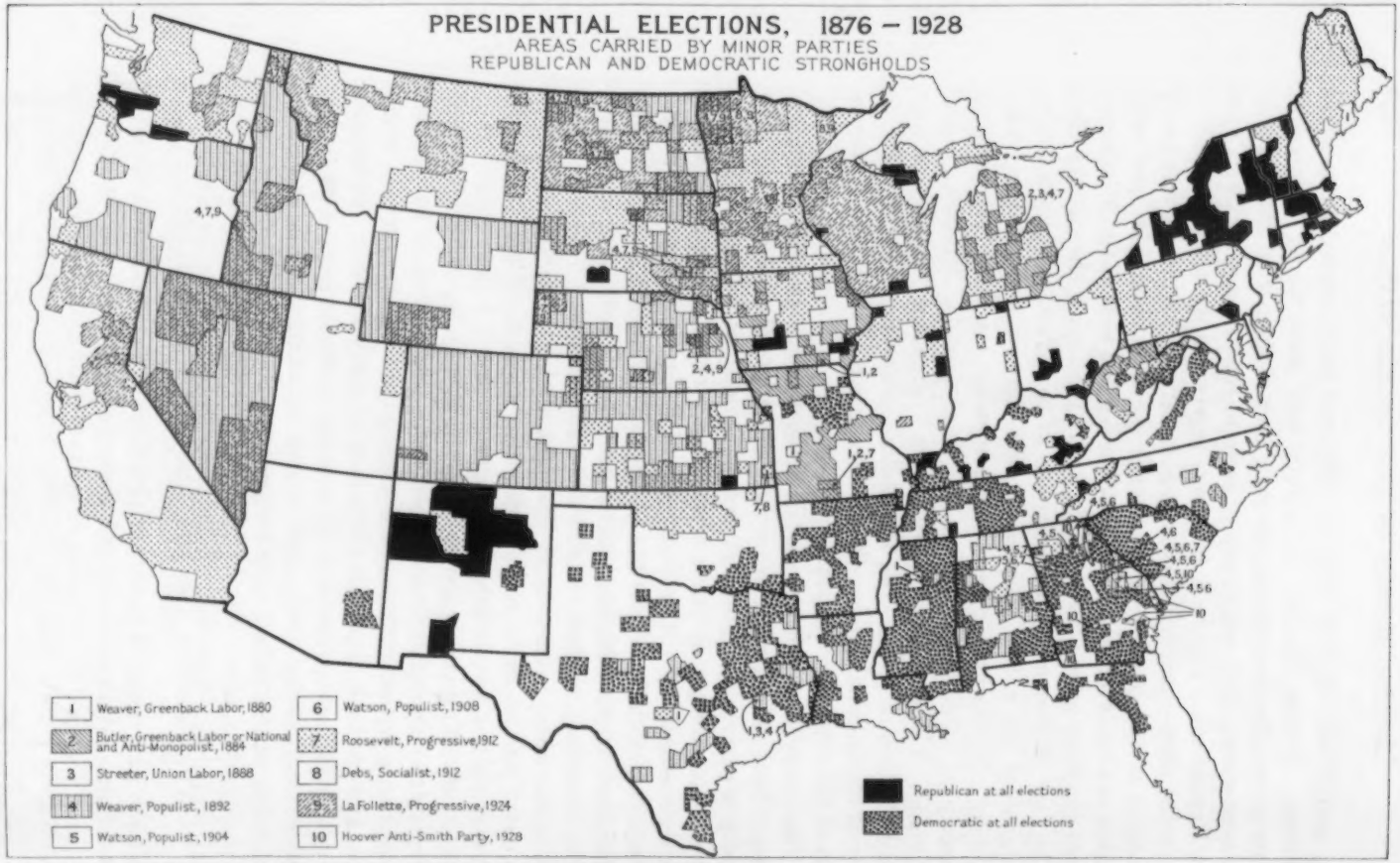
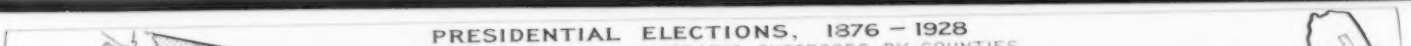


FIG. 1—Presidential elections, 1876–1928. Areas carried by minor parties and areas carried by the Republican party and by the Democratic party in all elections. Where they appear on the states specified the following symbols represent areas carried by fusion tickets: 1, Democratic with Greenback in Maine; 2, Democratic with Greenback in Michigan and Iowa; Democratic with Anti-Monopolist and Greenback in Nebraska; Republican with Greenback in Missouri and West Virginia; 4, Democratic with Populist in North Dakota; Republican with Populist in Alabama and Louisiana. Symbol 7 in South Dakota represents areas carried by a Republican ticket made up of Roosevelt electors; in Oklahoma it represents areas carried by electors on a Republican ticket partly for Taft and partly for Roosevelt



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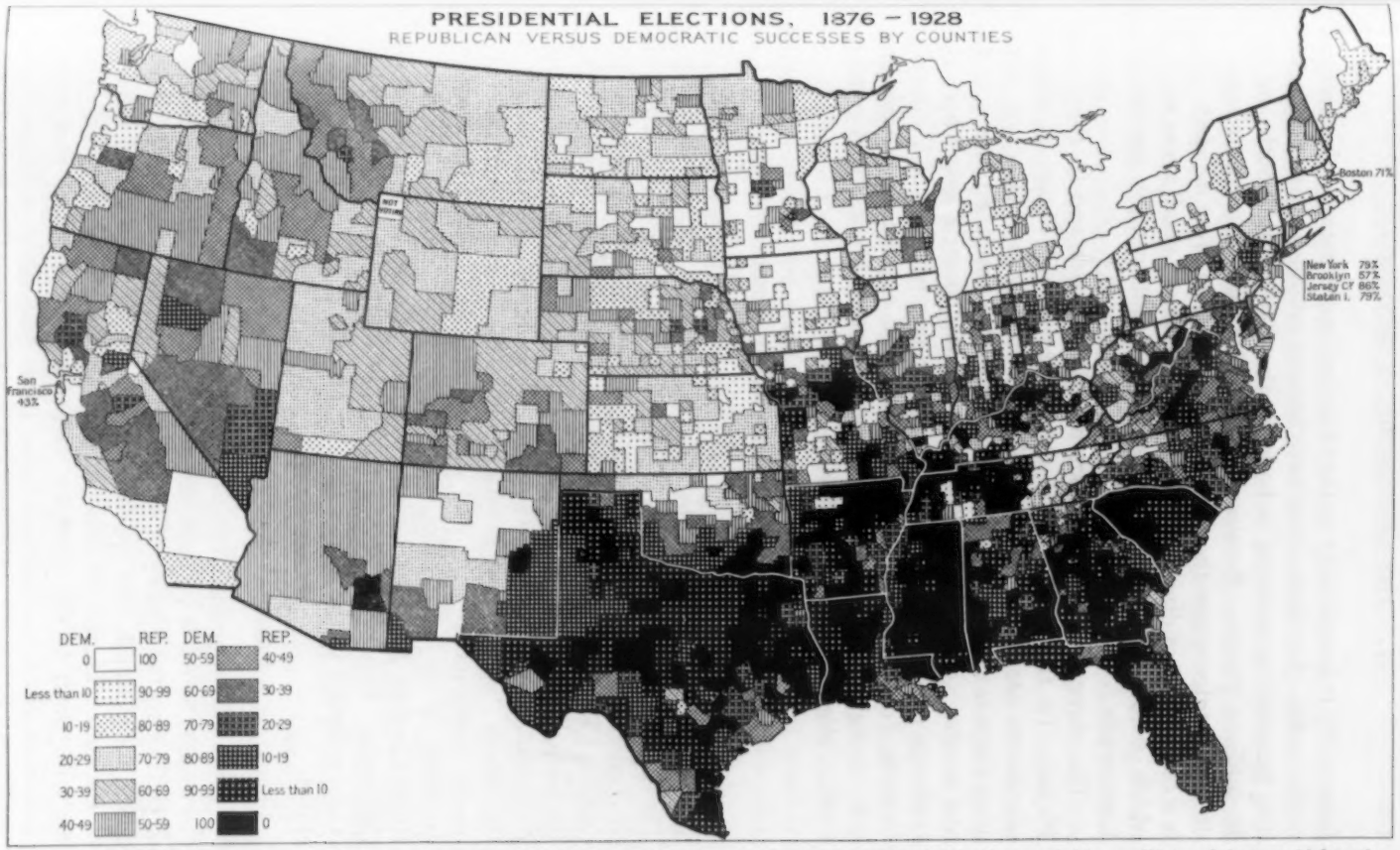

FIG. 2—Presidential elections, 1876–1928. For all counties 100 per cent represents the total number of presidential elections carried by candidates of the two chief parties during the period. The percentages of this total carried by each party are indicated by the symbols. (This map and Figure 1 were compiled by John Philip of the American Geographical Society from the original drawings for C. O. Paullin: Atlas of the Historical Geography of the United States, New York, 1932, Pls. 107–111.)

factors."[2] It is especially in the older and more conservative sections of the nation that these areas have become established and confirmed. The outstanding contrast is between the Democratic South and the Republican North. Between the two lies an intermediate zone of doubtful states where the outcome of elections is often decided. This is a borderland of divided loyalty, a patchwork of small areas most of which tend to be either persistently Republican or persistently Democratic.

The three zones of the eastern United States end in the Great Plains. To the west neutral shades prevail on Figure 2. Party alignments are not so rigidly localized as in the east. Here too, however, there is a suggestion of zones, but in this case the trend is north and south: Republicanism along the Pacific coast; a belt where the tendency is toward Democracy in the mining counties of California, Nevada, Idaho, and western Montana; and a generally Republican belt (though with notable exceptions) in eastern Montana, Wyoming, Utah, Colorado, Arizona, and New Mexico.

Settlement and Party Areas

Party affiliations that originated on or near the eastern seaboard have been carried across the continent on the tide of settlement. Those sections of the Middle West settled before the Civil War from the Federalist-Whig core of New England and New York have usually remained Republican. Hence the light shadings on the states fronting the Great Lakes, and in the Dakotas, Minnesota, Iowa, Kansas, and Nebraska, as well as in Oregon and Washington. Republicanism in the North "is strongest generally along the routes of capital, commerce, industrial energy, and density of population, with frequent exception of the great cities, where class voting modifies the rule."[3] Republicanism has also spread from the Middle West to southern California. Settlement of Northerners in Florida and parts of Texas is also reflected in the lighter shading of some of the counties in these states.

Party Areas in the Border States

From the geographical point of view the intermediate zone between North and South is perhaps the most interesting. Here the relation of politics to the history of settlement is everywhere evident. Oklahoma, for example, was opened to settlers within the period covered by the map. Those who came in from the North brought Republicanism with them to the northern counties. The southern and southeastern counties were settled from Texas and other southern states

[2] F. J. Turner: Geographical Influences in American Political History, *Bull. Amer. Geogr. Soc.* Vol. 46, 1914, pp. 591–595; reference on p. 591.

[3] *Ibid.*, p. 593.

and have remained Democratic. In the older states farther east, although the land was occupied by white colonists long before the opening of Oklahoma, the original party alignments still hold true to no less degree than in the newer state. Where the Southerners went, almost without exception, lasting promontories and islands of Democracy were formed.

The plantation system developed in those districts of the South where topography, fertile soil, and good drainage favored the cultivation of staple crops by slave labor. The Civil War and Reconstruction Period confirmed the Democratic loyalty of the old South and of the large landholders of Southern origin who had moved into the border states. The Democratic areas in Missouri, Tennessee, and Kentucky that appear so prominently on the map (Fig. 2) are for the most part areas of superior agricultural opportunity into which Southern planters had taken their slaves before the Civil War and where they had established a social and economic system like that left behind.

Professor Carl Sauer has discussed the party geography of Missouri, Tennessee, and Kansas.[4] His maps showing political areas are based on the vote for governors in 1915 and 1916 and correspond in all essentials with the facts brought out on Figure 2. Sauer shows that the Blue Grass Basin of Kentucky, its counterpart in Tennessee—the Nashville Basin—, and the alluvial lowlands along the Mississippi have long been areas of firm Democratic faith. These are also areas of relatively dense negro population. In Missouri the principal centers of the Democratic strength are the counties of the northeastern plain and of the Missouri Valley where it crosses the center of the state. This region was the first part of Missouri opened to farming on a large scale, and "the Missouri River counties, because of their settlement by slaveholders, still contain the highest percentages of negro population." Western and southwestern Missouri are also Democratic. They, too, were settled "at an early date via the Missouri Valley," although "a return movement of Southerners from Abolitionist Kansas" intensified their Southern character. Another Democratic nucleus lies in the rough country of the eastern Ozarks. "The amount of land that can be farmed here is small but the land is in general of good quality, consisting of limestone basins and alluvial bottoms. These limited tracts, near the Mississippi, were taken up . . . by settlers of Southern stock. The extreme roughness of the hills restricted the development of typical hill settlements, and the control rests therefore still with the old valley settlements."

[4] C. O. Sauer: Geography and the Gerrymander, *Amer. Polit. Sci. Rev.*, Vol. 12, 1918, pp. 403–426. This article illustrates by examples from the three border states the practice of gerrymandering—i.e. the arrangement of voting districts "so as to develop to maximum effectiveness the strength of the party in power and to render impotent the opposition groups." Professor Sauer shows that the gerrymander is "a violation of the geographic unity of regions" and indicates "the possibilities of equable representation by reorganizing electoral districts on a geographic basis." Gerrymandering of course does not affect the returns of the vote in Presidential elections as tabulated by counties.

Republicanism in the border states tends to be associated with the areas of less productive soils—the highlands or barrens cultivated by small farmers with little or no colored help. The mountains of western North Carolina and northern Georgia and the Cumberland Plateau of Kentucky and Tennessee have been almost undivided in their Republican sympathies. "The Republican character of the major part of the Ozarks [of southern Missouri] is analogous to the Republican nature of the hill districts of Kentucky and Tennessee, and the settlement was effected in large part by the same stock, reinforced later by small farmers from northern states." In the Republican area of west-central Tennessee "the land is generally poor in humus, and in places has been sadly damaged by soil erosion. . . . The scant agricultural attractions of the area have not resulted in the introduction of negro labor to any extent." On the other hand, Republicanism is not confined to the poorer lands. One of the best agricultural tracts in Tennessee, the Appalachian Valley, is staunchly Republican. This region was "occupied originally by small farmers, not slaveholders, who passed southward through this great structural valley, largely from the Scotch-Irish and German settlements of Pennsylvania and Virginia. Small grains, hay, and corn remained the principal crops, and the institution of slavery never became profitable or popular with these people. Thus does the story of political faith in the border states go back even today to the causes of an institution that has disappeared two generations since."

Party Areas in Illinois

Illinois furnishes a particularly striking example of the adjustment of politics to natural features. "In Illinois a map of party grouping looks like a map of the original forest and prairie areas, with the glacial lobe extending from Lake Michigan clearly visible. In eastern Wisconsin and in the Illinois [and Missouri] counties adjacent to St. Louis, the German area emerges, in the former as a group of Democratic counties in a Republican region . . . and in the latter regularly as a group of . . . Republican counties in a Democratic area."[5]

These words of the late Professor Turner show clearly that party politics are often deeply rooted in the facts of geography. It is largely to Turner's inspiration that studies of this sort owe their origin.

[5] Turner, *op. cit.*, p. 593.

THE INTERNATIONAL CONGRESS OF TRANS-OCEANIC AVIATORS

Sir Hubert Wilkins

THE International Congress of Transoceanic Aviators convened at Rome from May 22 to 25. Fifty-three aviators who had flown across oceans from one continent to another were the guests of the Royal Aero Club of Italy. There were representatives from England, Ireland, Germany, France, Spain, Portugal, Hungary, United States, Brazil, Uruguay, and Australia, together with the Italian aviators who flew in squadron from Italy to South America (1930–1931). The congress, which was presided over by General Italo Balbo, Italian Minister of Aeronautics, was called with the hope of effecting a centralization of information and initiating annual conventions to be held in various countries for the furtherance of closer relationships.

The congress resolved itself into two commissions, one with General Balbo as chairman to discuss South Atlantic routes, the other with Commander H. C. Richardson, U. S. N. retired, as chairman to discuss North Atlantic routes.

North Atlantic Air Routes

The North Atlantic Commission after much discussion presented the following conclusions.

The opening of a commercial air line is justified only when the flight from start to finish takes a shorter time than the journey by any other means of transport. Today Europe is linked with America by means of liners that take 4½ days to North America and 12 days to South America. It is unlikely that an air line using existing equipment could reduce the time of travel by more than two-thirds.

There are four possible routes across the North Atlantic. The first is the northern route by way of Labrador, Greenland, and Iceland. With existing equipment this route could be flown, as it affords intermediate stations at reasonable distances. It would be necessary, however, to establish complete meteorological and radio services and many landing and maintenance facilities. A definite survey of each step should first be made to determine the variation in route necessitated by daily and seasonal changes in conditions. Attention is drawn to the fact that during the summer fog seldom extends far inland or over inland waters and that generally when there is fog on one coast of Iceland it is clear on the other coast. This applies also to Greenland. It would be necessary to have alternate landing fields in both countries and have traffic directed by radio as circumstances required. It is considered that all-year flying is possible over Greenland to Iceland but that difficulties would be met in the form of icing of machines and irregular, suddenly changing strong winds on the North Sea section during the winter months. It is considered that flying boats could land and take off from the deep snow on the Greenland plateau and that lake landings in the northern areas would be possible except during two short seasons of the year.

The middle route is by way of Newfoundland and Ireland. It is considered that the "Newfoundland" station might be sited on the west coast of the island or on the mainland coast opposite so as to avoid landing and taking off in the very dense fogs occurring on the Atlantic seaboard. This route is considered the most dangerous and with existing equipment seems impracticable. However, it offers

the desirable features of shortness and facilities at each end. It is expected that improvements in all branches of aeronautics—speedy multiple-engined machines, fog-flying and fog-landing facilities, and radio control—will make this route possible, especially from west to east. But attention is drawn to the fact that, so far as can be estimated, an east-to-west crossing would take the best existing machines from eight to ten hours longer in flight.

The southern route by way of Newfoundland and the Azores offers the same difficulties as the middle route and also lengthens the journey.

The extreme southern route by way of Bermuda and the Azores offers little if any advantage in weather conditions and has the added disadvantage that the archipelagoes have no sheets of water suitable for take-off with heavily loaded machines and no convenient landing facilities. In any case the route is too long to be considered profitable with existing equipment.

South Atlantic Air Routes

The South Atlantic Commission in a 16,000 word resolution concluded that the atmosphere conditions in the South Atlantic, in the zones considered, are such that safe and regular traffic could be carried on at all times and that night-and-day flying could be maintained.

It is considered that sufficient data have been collected to justify the inauguration of an all-air route from Rome to Buenos Aires. Two substantially different routes are suggested, one via the Cape Verde Islands and northern Brazil and the other a non-stop, all-water route between the western mainland of Africa and northern Brazil. The latter offers alternatives on the African part of the journey, one course following the coast from Tunis over Algeria, Morocco, Rio del Oro, Senegal, and Gambia to Bolama in Portuguese Guinea, the other line from Tripoli following the more important caravan routes across the Sahara.

Considering Rome as the starting point and Buenos Aires as the terminal, the Cape Verde route is shorter by 124 miles than the coastal route, but the departure from the Cape Verde Islands of a heavily laden hydroplane is often impossible because of the absence of a sufficiently large area of sheltered water. The inland African route, following the caravan trails, is 80 miles shorter than the coastal route or only 44 miles longer than the Cape Verde route. However, the coastal route offers considerable advantages.

For convenient consideration the South Atlantic route might be divided into four sections: the Mediterranean, the west coast and northwestern Africa, the South Atlantic Ocean, and the east coast of South America. It seems advisable to use two types of equipment, hydroplanes for the Mediterranean and South Atlantic crossings, and land planes for the northwest African and South American sections. Many of the ground organizations—such as weather stations, customs, landing facilities, ground communications—are already established along the routes considered.

The climate in the Mediterranean section has two distinct seasons, the rainy winter and the dry summer. There are some short periods of fog, but this in general does not represent a serious handicap to aerial navigation. Winds are variable but rarely strong except for a short period in winter and early spring. A few storms may be expected, but experience has shown that these can be avoided.

On the west coast of Africa the northeast trade winds prevail and would offer south-bound planes the advantage of from 10 to 20 miles an hour according to the season of the year. The height of the trade winds is not well determined, but it seems likely that by keeping below 1000 meters there would be an advantage going south and by rising above 2000 meters the north-going planes would top the trades.

The course across the South Atlantic Ocean from the Bissagos Islands in Portuguese Guinea to Cape San Roque in Brazil passes through three regions with quite distinct aerological characteristics—those of the northeast trades, the equatorial calm, and the southeast trades. There is very little fog on the route across the South Atlantic, but visibility might be low on account of the mists formed by the tropical rains.

South of Cape San Roque along the east coast of South America weather conditions are variable, but fogs are rare except at the extreme end of the route and even here are of short duration.

Much of the South Atlantic air route from Rome to Buenos Aires is already being flown by various air lines, but there is in Italy a proposal to establish at an early date a complete air service, flying night and day and having a schedule out and back once a week, the journey to occupy a total time of 88 hours as compared with 12 days on shipboard.

For the convenience of the established lines and for the benefit of the one newly proposed, it is recommended that there should be established a central weather station at Bolama, Portuguese Guinea, to receive information from merchant ships frequenting the South Atlantic and from a ship attached to the station which would visit the areas less frequented by merchant shipping. The commission also recommends the establishment of a research station in connection with the weather station at the Canary Islands, whose geographical position is particularly favorable for the purpose of aerological study.

The congress, in general session, lauded the initiative taken by the Royal Italian Aero Club and expressed a desire for the complete and closer coöperation of the nations concerned with the Atlantic routes. It was proposed that steps should be taken to make arrangements for holding the next conference of transoceanic aviators at Chicago in 1933.

GEOGRAPHICAL RECORD

SOUTH AMERICA

A Vegetation Map of Paraná. Among several recent German studies on the vegetation of South America an outstanding contribution comes from Professor Maack on the Brazilian state of Paraná (Urwald und Savanne im Landschaftsbild des Staates Parana, *Zeitschr. Gesell. für Erdkunde zu Berlin*, 1931, pp. 95–116).

FIG. 1—Vegetation map of Paraná (after the map "Wald und Savanne im Staate Paraná" by Reinhard Maack, 1 : 1,975,000). Key: 1, coastal zone, including mangrove, xerophytic plants, palms, and selva; 2, Araucaria region; 3, yerba maté in pure stands; 4, savanas; 5, evergreen broad-leaf forest; 6, transition forest: areas of important settlement stippled. Scale of map approximately 1 : 6,000,000.

The map in color accompanying Maack's paper is here reproduced with slight modification in black and white on a reduced scale. The first main vegetational division is the "coastal region." Along the immediate coast there is a series of vegetation zones. Mangrove lines the swampy borders of the bays. Beyond, or bordering the open sea, is a zone of low xerophytic plants. This merges inland into a zone of xerophytic bushes and low trees. Then on the slopes of the escarpment there is a strip of evergreen rain forest, rich in epiphytes and lianes—near the southernmost limit of the tropical rain forest.

The most extensive area is that occupied by the *Araucaria*, or the Paraná pine forest. This begins sharply at the crest of the coastal escarpment (1000 meters elevation). It extends inland, interrupted in places by savanas, covering nearly all of the plateau that lies above the 500-meter contour. Below this elevation the broadleaf forests are found. The Paraná pine forest itself, however, varies from place to place. Pure stands of pine are found in the higher areas—mountain tops and higher parts of the plateaus; but throughout most of the region there is a mixture

of broadleaf trees and bamboo thickets with the pine. The yerba maté is one of the broadleaf trees of this region, occurring in almost pure stands in a few places in the western part of the state.

Below the 500-meter contour the *Araucaria* gives way to broadleaf evergreen forests in the northern and western part of the state. In some of the valleys below 500 meters, as the valley of the Rio Piquiry, there is a transition zone in which the *Araucaria* is still found. Elsewhere the lower elevations are occupied by a tropical rain forest, with epiphytes and lianes. In the southwest, however, the cooler temperatures cause a gradual diminution of the epiphytes: the broadleaf forests change gradually from typical *selva* to the subtropical evergreen forests of lower middle latitudes. The Rio Paraná forms the western boundary of this forest, for beyond, at least in the north in Matto Grosso, the forest gives way to savanas.

The *Araucaria* region is broken from São Paulo in the northeast to Santa Catharina in the southwest by open grasslands, the *campos geraes*. Unlike the savanas in São Paulo and Minas Geraes, in which is found a scattering of trees and bushes, the savanas south of the Rio Itarare are for the most part pure grasslands. Isolated groves of trees occupy the ravine heads to which forest type the Germans apply the expressive term *Quellkopfwäldchen*. Maack believes that the present extent of these grasslands is due to burning and that otherwise the forests would gradually encroach upon the openings and eventually close them.

The extent of the area occupied by settlements and so partially cleared is indicated by stipple on Figure 1. The destruction of the forest by burning has proceeded rapidly in this part of the state, much valuable timber being lost. In the far north of the state the clearings have been planted to coffee; but the more extensive crops are maize, wheat, rice, manioc, potatoes, beans, with smaller but important areas of fruit and vineyards. The *Araucaria* region and the savanas are free from malaria, and are therefore more suitable for colonization than the coastal zone or the broadleaf forest region below the 500-meter line in the interior. Only under the lure of coffee has this latter region been penetrated.

PRESTON E. JAMES

Snow Line and Tree Lines in the Andes. That tree lines are more a matter of the ecological characteristics of the trees in a given place than of any general climatic limit is brought out in a recent study of Andean tree lines (Theodor Herzog; Baum-(Wald-) und Schneegrenzen in den Kordilleren von Südamerika, *Mitt. Geogr. Gesell. zu Jena*, Vol. 39, 1931, pp. 72–89). In general, the tree line is highest on the dry Bolivian plateau (4800 to 4900 m.) and lowest in Tierra del Fuego (about 350 m.). On the eastern Andean front the upper limit of the closed montane forest in Peru and northern Bolivia is about 3400 meters; but with a change in the type of forest in the higher latitudes of southern Bolivia the tree line drops abruptly to 2900. The snow line on the west side is highest in the southern part of the Atacama Desert (6300 m.), and lowest in Tierra del Fuego (750 m.). Near Lima it lies about 5000 meters; near Arequipa, about 5760; on the tropic, 6000; and at 32° S., about 3400. On the eastern side the snow line is highest in southern Bolivia (5900 m.) and lowest in Tierra del Fuego (900 to 1000 m.). In northern Bolivia it is about 5200 meters, and near Mendoza in Argentina it lies about 4200 meters. In general, the snow lines and tree lines come closer together in wetter places, and the widest spread between the lines is in the drier areas.

PRESTON E. JAMES

Eruptions of the Volcano Tunguragua in Ecuador. The beautiful snow-capped volcano of Tunguragua stands on the eastern slopes of the Andes, some fifty miles south of Cotopaxi. An interesting description of its eruptions, which are among the greatest known in Ecuador, has been written by Nicolás G. Martínez, of the observatory of Quito ("Las grandes erupciones del Tungurahua de los años de 1916–1918,"

Quito, 1932). The first eruption of which we have reliable historical proof was that of 1773, after which the volcano was dormant till the great eruption of 1886. After this with the exception of emission of decreasing amounts of gases, the volcano was quiet till March 3, 1916, when it suddenly broke out in violent eruption. The eruptions continued till March 11 and after nearly a month of rest a final eruption took place on April 13. No further eruptions took place till January 5, 1918. On February 10, March 15, April 5, May 18, June 25, and November 16, 1918, violent eruptions took place.

Martínez describes the phenomena, which he personally observed during the eruptions of 1916 and 1918, and especially the *nubes ardientes* (fiery clouds) which he states were first noted by him in Ecuador, subsequent to Lacroix' discovery of the phenomenon (*nuée ardente*) at Pelée in 1902. He believes that this phenomenon has occurred in previous eruptions in Ecuador but has not been recognized, being confused with the effects of true lava streams.

Ash from the March 16, 1916, eruption of Tunguragua fell as far as the Pacific Ocean, 240 kilometers distant. Martínez calculates the amount of ash that fell during this eruption in the province of Tunguragua alone at 26,000,000 cubic meters.

JOSEPH H. SINCLAIR

The Distribution of the Changos in Chile. On the northern coast of Chile are to be found small isolated groups of primitive fisher folk, the Changos. In the extreme south are the primitive fisher folk, the Alakaluf and Yaghans. Are they related, possibly the same tribe? Doctor Walter Knoche (Zur Verbreitung der Changos in Chile, *Verhandlungen des Deutschen Wissenschaftlichen Vereins zu Santiago de Chile*, New Ser. Vol. 1, 1931, pp. 16–33) propounds a theory that such relationship may well have existed, basing it upon a study of geographical names of probable Chango origin encountered along the Chilean and southern Peruvian coasts. He has compiled a list of 101 place names which, from their similarity to Chancos (Changos) and the supposedly kindred forms Chanqui and Cunco, presumably originated with these people. Geographical coördinates of points thus designated show a spread in latitude of 36 degrees, over half the length of the South American continent. If doubtful names are eliminated from the list there is still evidence of the Chango spread from latitude 13° 37′ to 42° 20′ S. Unfortunately the sparsely inhabited island region south of Chiloé was mapped almost exclusively by British and Chilean naval vessels, and place names of the aborigines have been mostly lost. Otherwise Dr. Knoche believes that a relationship might be established between the Alakalufs and the Yaghans of Tierra del Fuego and northward, and the Chonos and Chilotes who reached as far north as the Rio Valdivia and who in their turn are perhaps linked to the Changos through the related name from Cuncos.

While most of the names in the list designate places at the coast, a number are at short distances inland, points probably visited by the Changos in quest of potable water or vegetation. Dr. Knoche brings an interesting thought in the association of fisher tribes of Chile's arid north with those of its humid south. Were southern people carried northward in their frail boats by prevailing winds and currents, either with or against their volition, or were northern people caused to shift southward as a result of being crowded out by other tribes?

W. E. RUDOLPH

EUROPE

A Rainfall Map of the Iberian Peninsula. Following up earlier studies on the rainfall of northern Spain and Portugal, W. Semmelhack completes the rainfall map for the Iberian Peninsula as a whole (*Annal. der Hydrogr. und Marit. Meteorol.*, Vol. 60, 1932, pp. 28–32). With the map he publishes a list of annual averages for 89 stations reduced to the period 1861–1900, 35 of which are for 20 or more

years. These averages are more interesting than the map itself, for this offers little variation from earlier ones. The averages show how slight is the base of observation on which the Iberian isohyetals rest. Yet they will probably prove to have been well placed, for they are based on a topography that is known.

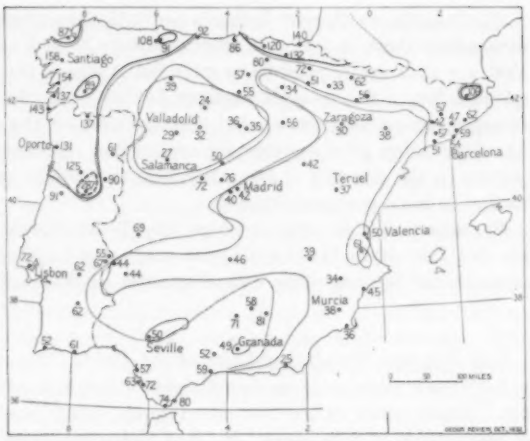

FIG. 1—Rainfall of the Iberian Peninsula, after Semmelhack (1932). Semmelhack's 50- and 100-centimeter isohyets are shown in solid lines (the original also shows 30, 40, 60, 70, 80, 90, and 150 cm. isohyets) and in dotted lines Reger's isohyets of 1903 (compare the note "A New Rainfall Map of the Iberian Peninsula," *Geogr. Rev.*, Vol. 17, 1927, pp. 153–154). Dots for the stations listed, with rainfall in centimeters, are added to bring out their paucity in the vastness of Iberia. Scale 1 : 16,000,000.

The picture is a familiar one to all students of Iberian geography: abundant rainfall along the Pyrenees and Cantabrian mountains and well down into Portugal as much as 70 miles south of Oporto, where the country is green even in the drier time of summer; quite scanty rainfall with intense summer drought in the basins of Duero, Ebro, Guadalquivir, and Segura—the sites of the storied towns of Valladolid, Salamanca, Zaragoza, Seville, and Murcia. The partings between the basins are wetter but still somewhat droughty, the greatest precipitation between Old and New Castile being at Avila (72 centimeters) and the Escorial (76 centimeters), while Madrid has 42 centimeters (17 inches). The rainiest spot of all Iberia is the Serra da Estrella (287 centimeters) at an elevation of 1450 meters. The ridge reaches greater elevation in Spain but has less rain because farther from the sea. The stations in the northwest corner of the peninsula are all at much lower levels. They are identifiable on the map by their numbers of centimeters of rain—La Coruña (87), Santiago (158), Pontevedra (154), Vigo (137), La Guardia (143), with Orense (89) in the valley of the Minho, deep below the encircling heights. No doubt the upper levels of the Galician tableland get a precipitation of 200 centimeters or more. The map's picture of abundant rain in the northwest rests on records of only the seven stations named with Oporto (131), Vizeu (125), and Montealegre (137) in Portugal, and Arnao (108) on the Bay of Biscay.

Hellmann's map of 1888 (*Zeitschr. Gesell. für Erdkunde zu Berlin*, Vol. 23, 1888) drew its 100-centimeter isohyetal west of Orense and La Coruña, giving the whole north coast west of Bilbao less than 100 centimeters. That was a much smaller patch of abundant rain for the northwest than other maps show, but in reality there is probably much more than 100 over the whole northern plateau, with lesser values only in the sags and valleys where men have placed their cities. For water supply and flow of rivers it is the upland rainfall that governs. The apparent greater rainfall by all maps on the Pyrenees means only that over there the relatively low places where men live are all high up—Pamplona (72), Iaca (62), and Olot (76).

As a matter of fact we have no records of rainfall in the Pyrenees or the Cantabrian Mountains. When we have them they will doubtless prove very large. Such reasoning must lie behind the drawing of the isohyetals in Spain on Semmelhack's map. He has inserted 80 centimeters on the Sierra de Gredos, another long strip for 70 miles along the ridge west of the Escorial (76) neither of which corresponds to any observation station listed.

Again in the south near Granada Semmelhack inserts four patches of 80-centimeter rain where there is only one observation so high, Cazorla (81 centimeters), though that one does not happen to be included in any of the patches drawn. One of these patches lies in the triangle between Seville (50), Malaga (59), and Gibraltar (80). No observation station is listed there at all. At the moment we can only know it by observation of the mountain vegetation. Evidently there is much that is subjective in the drawing of the isohyetals, though no mention of this is made by the author in his accompanying text.

Parenthetically it may be noted that Semmelhack has a paper "Temperaturkarten der Iberischen Halbinsel" with maps and tables in the August number of the *Annalen der Hydrographie und Maritimen Meteorologie.*

MARK JEFFERSON

ASIA

Lop Nor, the Wandering Lake of the Gobi. One of the most baffling problems of high Inner Asia has been that of the existence and location of Lop Nor. Apparently the Chinese knew of its existence two thousand years ago and made rough maps of its contour and location. In 1733 Europeans were first made aware of it when Lieutenant Gustaf Renat of Sweden and d'Anville of France, independently of each other, brought back maps of Central Asia based on Chinese sources. These showed a large inland sea, named Lop, in the northern part of the Gobi, subsequent investigations indicating that Renat's map was the more accurate. Marco Polo, who in 1273 crossed the desert just south of the reputed location, was silent on the subject. About 1760 the Chinese government sent a surveying party of three Jesuits to the area, but they failed to report any lake—only flat monotonous desert. More than a century elapsed and then came Przhevalsky's report of his exploratory trip of 1876–1877 in which he stated that Lop Nor was a full degree farther south than shown on the old Chinese maps. Thus arose the controversy whether the maps were in error, or Przhevalsky had discovered a hitherto unknown lake, or whether the streams flowing into ancient Lop Nor had shifted southward and created a new lake there and abandoned the old one to desiccation.

The story of the solution of this problem is told clearly and almost dramatically in recent articles by Sven Hedin and Nils G. Hörner (Sven Hedin: Lop-nor: Den vandrande sjön, *Ymer*, 1931, pp. 121–153; *idem:* Lop-nor-problemet löst! *ibid.*, pp. 342–344; Nils G. Hörner: Upptäckten av nya Lop-nor, *ibid.*, pp. 344–378). In the first-named article, an English version of which forms the conclusion of his book "Across the Gobi Desert" (1932), Dr. Hedin reviews the historical setting, illustrating it with numerous maps, and points out the significance of the problem. In his first exploratory trip into Central Asia Hedin had followed the east bank of the Tarim River (the stream that was reputed to discharge into Lop Nor) and had found it turning sharply southeastward and emptying into a large lake in the southern part of the desert. This verified the then-existing location of a lake as described by Przhevalsky, but the problem of ancient Lop Nor was unsolved. Hedin had, however, observed farther north, where the Tarim turned southward, a large, dry stream bed extending eastward but had no opportunity to follow it. In 1900 he returned and mapped the old river channel (for such it proved to be) eastward through two and a half degrees of longitude. He then reached the conclusion that the entire Tarim had formerly occupied this old channel eastward. Returning to the southern lake he found it shallow and full of silt and slime, apparently rapidly filling through sedimentation from the inwash of the Tarim River. Hedin then turned northward across the desert. Near where he had located the former channel he discovered the well preserved ruins of a town. Its importance was proved by the discovery of more than 150 manuscripts on paper and wood many of them with dates ranging from 260 to 330 A.D. and stating that the name of the place was Loulan. East and south of Loulan the landscape seemed to be a flat desert, but careful leveling proved the

existence of a broad, shallow depression with an old strand line near the site of Lou-lan. On this evidence as a basis Hedin wrote ("Scientific Results of a Journey in Central Asia, 1899–1902," Vol. 2, p. 355):

"In the light of the knowledge we now possess, as to the relations of level that obtain in the Desert of Lop, it is not too bold a thing to say, that some time the river [Tarim and its tributary, the Konche-darya] *must* go back to the Kuruk-darya . . . It is merely a question of time, but the country hereabouts will become so choked with alluvia that the river will be forced to return to its northern bed. The lowermost limb of the river thus oscillates backwards and forwards like a pendulum . . . the periodic time of each oscillation . . . 1500 years . . . "

Hedin's next expedition into this area was in 1927. In the spring of 1928 he learned that the change in course had actually taken place just as he had forecast thirty years previously that it would. A 1500-year cycle had made its turn. The Tarim River had shifted from its southerly course, was no longer discharging into the southern lake, but was flowing full force eastward through the old dry channel, the Kuruk River, which he had mapped in 1900!

In the second of the three articles mentioned Hedin points out that this change makes possible and likely a return of trade to the route along the northern part of the desert, the same one that was formerly part of the longest caravan route in the world, carrying the silks of the East to the Roman nobility in the West (see Albert Herrmann's recent volume, "Lou-lan," 1931). He advocates the construction of a motor road to connect this great western province with the railroads of eastern China and thus open trade possibilities with the world at large. He also summarizes the more recent accomplishments in making a detailed map of the new Lop Nor and the significance of the studies of late Quaternary and recent changes of level due to sedimentation and in some degree to crustal warping.

In the third article of the series is given the report of Nils G. Hörner, who was in charge of the fieldwork involved in mapping the new lower course of the Tarim River and the present outline of the new Lop Nor. It is a fascinating presentation of the scientific results attained, the methods that were devised to overcome unlooked-for difficulties, and the type of problems that must be met in a terrain now being converted from a salt-crusted desert into an inland saline sea.

NELS A. BENGTSON

POLAR REGIONS

The Wegener Greenland Expedition of 1930–1931. A preliminary report on the results of the Wegener Greenland Expedition of 1930–1931 has been issued by the Berlin Geographical Society (Deutsche Grönland-Expedition Alfred Wegener: Gedächtnisfeier für Alfred Wegener . . . , *Zeitschr. Gesell. für Erdkunde zu Berlin*, 1932, pp. 83–145). Almost simultaneously there has appeared a popular narrative volume with non-technical scientific reports by members of the expedition (Else Wegener, edit.: Alfred Wegeners letzte Grönland-fahrt: Die Erlebnisse der deutschen Grönlandexpedition 1930–1931, Leipzig, 1932). The following brief survey will make clear the great importance of the scientific work accomplished.

Meteorology. The expedition, it will be recalled, planned stations on the east and west coasts and in the interior. The east station was in charge of Dr. Walter Kopp of Lindenberg. At this station registering balloons were sent up to elevations of 4000 meters and pilot balloons to 6000 meters. It had been the plan of Dr. Wegener to erect the east station on one of the Scoresby Sound fiords just outside the margin of the inland ice. Owing to ice difficulties it was not possible to do this, and moreover it was not found possible to maintain the station throughout at one place. From August 9, 1930, to the end of the month the station was established at the settlement, that is, near the mouth of Scoresby Sound. Then it was moved to the low plain of

Jameson Land at a point 5 meters above tide and about 150 kilometers from the colony, in latitude 71° 10′ N. and longitude 24° 24′ W. Here throughout October ascents were carried out regularly. It was found that quite close to the ground a wind blew off the land toward the fiord; but often at a height of only 10 to 20 meters calm conditions were encountered, and these extended up to 600 to 1000 meters, at which level the strong west-northwest winds blowing off the inland ice dominated completely. Kite ascents were made to 3000 meters, and these in winter showed an enormous inversion—a rise of more than 20° C. in 100 meters. Pilot balloon ascents were carried out in winter to a height of 7000 meters. The maximum reached with registering instruments was 5000 meters and that with pilot balloons 15,000 meters. In all some 283 ascents were made.

Eismitte Station. The central ice-cap station under the direction of Dr. Johannes Georgi of the Deutsche Seewarte at Hamburg was located at a point nearly 400 kilometers from the western margin of the ice. The site had been chosen so as to be nearly as practicable upon the medial line of the ice cap, rather than at the crest of the dome, as had been the plan of the British expedition under Watkins (see below).

An initial delay in 1930, due to ice conditions, prevented the greater part of the aerological equipment from reaching the central station (and, it may be parenthetically remarked, was largely responsible for the tragic loss of the leader of the expedition). Of the 200 ascents that had been planned only 54 were carried out, of which number 17 ascents were of captive balloons and 37 of pilot balloons. Twenty-nine of the latter were followed to heights of 10,000 meters or more, with the highest at 17,500 meters. Cloud measurements made with the theodolite numbered 104, and all the represented cloud types were included. Georgi states that the observations repeatedly confirmed the independence of the upper winds from the near-surface currents.

The average wind velocity at the station was 4.6 m/s, or 10¼ miles an hour, and it is pointed out that this indicates some variation from the central cold area as marked out by Koch and Wegener. The writer would point out that the cold and relatively calm area should be symmetrical above the crest line of the ice rather than the medial line of the continent; that the profile of the route to the station indicates that the crest of the ice dome lies to the eastward of the station; and, further, that the observations of Höygaard and Mehren made during their crossing in 1931 ("Ajungilak" eller Grönland på Tvers, Oslo, 1931) indicates that this divide must be at least 60 or 70 miles farther to the eastward. Thus the figures obtained for wind velocity are in no way surprising.

For a complete year (372 days) ground observations for a meteorological station of the first class were recorded at Eismitte. The minimum temperature recorded was −65° C. (−85° F.). Solar radiation studies were especially emphasized at the central station. Much attention was also given to the vitally important problem of the changes of snow surface temperatures at sundown.

The West Station. As was the case with the east station, the west station, under Dr. Rupert Holzapfel, was not located at a single site throughout the year of observation, and in view of the exaggerated importance of local differences in meteorology throughout the region this is much to be regretted. Though in identical altitude and only two kilometers apart, the differences in the measurements of the meteorological units at the two sites were so large and of so irregular a nature that they cannot well be united even for the winter season.

Stations supplementary to the main west station on Kangerdlukssuak Glacier were established at Umanak and at Kamarujuk on the coast with a view to gaining a picture of the effect of the marginal fiord system outside the inland-ice margin. It was thus found that, when the inner fiord only was ice-covered, Umanak was under the domination of the cyclones within Davis Strait but, when the ice cover extended to the outer fiord, Umanak was dominated by the glacial anticyclone.

The aerological studies at this station were made on the Scheideck nunatak at an altitude of 950 meters. The outstreaming air of the glacial anticyclone reached up above the station in the summer only 300 to 500 meters. Above this level the air was calm, and at about 4000 meters above sea level the instreaming air currents became noticeable. A limited number of balloons were sent up at this station. The maximum elevation reached was 26,000 meters.

Geodesy. Astronomical determinations of position were made over the inland ice at eleven stations along the route to the interior and gravity measurements at three stations—at 85, 120, and 400 kilometers from the margin of the ice. Under the greatest difficulties, due in large part to the weather but also to the very remarkable refraction of the air over the ice, a precise profile based on trigonometrical levelings was prepared in several sections and, while it was not completely closed, constitutes a great achievement. It enhances the value of the soundings of the ice, of the gravity measurements on its surface, and, most of all, of the meteorological and aerological data obtained at Eismitte. With the use of a meteorograph carried on the dog sled a profile based on barometric readings was made for comparison and checked by readings of mercury barometers at Eismitte and West stations, and at sea level on both coasts.

Ice Soundings. The determinations of thickness of the ice cap obtained by the preliminary expedition of 1929 (cf. *Geogr. Rev.*, Vol. 20, 1930, pp. 681–682) were extended by 31 additional soundings. Like the earlier data these seem to indicate considerable irregularity of the rock floor, though the saucer form seems to continue to the end of the profile at Eismitte. At Eismitte, which is at an altitude of about 3000 meters, the rock floor was found to be between 300 and 500 meters above the sea. The soundings further indicated the depth of névé upon the glacier surface, this contact being relatively definite in the outer portions but much less so below the interior station. At each locality where the new soundings were carried out it was necessary to spend six days, and it was wholly due to the propeller sledge, which proved a notable success in the 1931 season's work, that they could be made at all.

Shafts were put down in the snow beneath the west station to a depth of 20 meters and beneath Eismitte to a depth of 16 meters. At Eismitte the temperature of the snow was found to rise from one half a degree to a degree centigrade between the depths of 6 and 16 meters. Down to a depth of some meters the névé contained air, the expulsion of which in sudden shocks was believed to be the cause of the *firnstösse* that occasioned much anxiety at the central station, where it was feared that the snow roof would collapse on the observers.

In the preliminary survey by Dr. Kurt Wegener who succeeded his brother in command of the expedition, there appears a tendency to attempt to settle a number of puzzling problems by computations that involve considerable assumption and leave out of consideration certain necessary factors. This appears especially in computing the rate of horizontal movement of the ice beneath Eismitte and also in estimating the rate of melting on the rock floor beneath the glacier. Furthermore, it hardly lends perspective to the picture of the glacial anticyclone, which is given such striking and even tragic confirmation by the Wegener Expedition, to compare it with the light land breeze of a tropical island. The assumption, also, that cyclones and high pressure areas alike wander or "spring" over Greenland "almost as if the continent which reaches to alpine heights did not exist" is based upon synoptic charts prepared from observations at the widely separated stations deep down in the mouths of fiords, which data are wholly unreliable for such use. Such a conclusion finds little support in the experiences of explorers upon the inland ice.

The facts derived from the expedition are of outstanding importance and constitute a monument to the heroic leader who perished on the ice cap. There was also much of the heroic in the work of those who manned the central station, and especially Dr. Georgi who carried on alone for such long periods. The full reports, which are

promised within a year, will be looked forward to with the keenest interest. The reduced aerological observations of the two University of Michigan stations, one in latitude 73° on the northwest coast of Greenland, the other at Ivigtut in far southern Greenland, maintained simultaneously, are now in the hands of Dr. Georgi to be compared with those from Wegener's three stations. Thus for the first time a comprehensive comparative study of such data from more than a single Greenland station will be accomplished.

W. H. Hobbs

The British Arctic Air Route Expedition. The object of the British Arctic Air Route Expedition, directed by Mr. H. G. Watkins, was to investigate the possibilities of an airway between England and Canada via Greenland (H. G. Watkins: The British Arctic Air Route Expedition, *Geogr. Journ.*, Vol. 79, 1932, pp. 353–367 and 466–501). The main base was established some forty miles west of the chief settlement at Tasiusak (Angmagssalik). Some twelve miles to the northwest of the base was a glacier outlet from the inland ice. Up this glacier and beyond the crevassed area that marked the edge of the ice cap a food depot was established at an elevation of 3960 feet. This was the starting point of all journeys on the inland ice.

At the outset a dog sled journey was undertaken to the crest of the ice dome to establish the central meteorological station. The site chosen was at an elevation of 8200 feet and in a direct line between the main base and Disko Island, on the proposed route London, Aberdeen, Faroes, Reykjavik, Angmagssalik, Disko, Cumberland Sound, Southampton Island, Fort Churchill, Winnipeg. This station was manned in relays from August 29, 1930, to May 5, 1931, during the last five months by Augustine Courtauld alone.

Of the seven additional journeys of the expedition, not to mention flights to the ice-cap station, five were by dog sled over the ice cap; one in the expedition's ship, the *Quest*, with seaplane and motor boats to survey the shore region to and about Kangerdlugssuak 250 miles northeastward up the coast; and one to survey the southeast coast of Greenland as far as Umivik and thereafter in reconnaissance fashion to Julianehaab in the extreme south. In addition there were four relief expeditions to the ice-cap station. Mere enumeration of the journeys is, for anyone familiar with the difficulties, sufficiently impressive. They constituted a series of notable achievements possible only because individual members of the expedition became leaders of parties and carried on like veterans, though many of them were without earlier experience in Arctic work.

The routes followed were such as to derive much knowledge concerning the interior cold and calm area of the ice-cap surface. The journey of Watkins in September and October of 1930 within the central area southward from the ice-cap station was of value in confirming all earlier transection expeditions, since it showed the interior snow to be soft and deep. Instead of being level, however, the surface was found to consist of circular hills about 100 feet high and two miles apart with the general level declining to the southward.

The second relief of the ice-cap station, undertaken in November, encountered terrible weather. A blizzard from the northwest blowing down the slope of the ice occurred every two days. Only as the party neared the station, which they reached after thirty-nine days' traveling, did the storms let up. Here Courtauld volunteered to man the station alone until May, when he was to be relieved. The other four men made the return journey in nearly continuous blizzards. An attempted relief made in March during terrible weather returned without being able to find the station. A fourth relief party set out on April 21, when the spring weather had already come. On their journey no blizzards were encountered, and Courtauld was relieved on May 5.

The coast journey to Kangerdlugssuak (August-September, 1930) and the sled journey to Mt. Forel (May-June, 1931), 100 miles northerly from the base are

described at greater length by A. Stephenson in the July, 1932, number of the *Geographical Journal* (pp. 1–14). The height of Mt. Forel had been estimated by de Quervain from a distance of 70 miles as about 11,000 feet. Mr. Stephenson's party climbed within 700 feet of the top, determined as 11,100 feet.

Scott, Stephenson, and Lindsay, who crossed the inland ice to Ivigtut on the south coast, kept as close to the marginal mountains as possible until near the latitude of Umivik. They found the ice high and the eastward slope steep and much crevassed. From the latitude of Umivik they struck southwestward directly toward Ivigtut and soon reached the crest of their section at 9200 feet altitude. Down the slope toward Ivigtut sails were used with following winds. This journey of 448 miles was made in 26 days. The weather on the journey, which was in July, was good almost throughout; and the temperature was always above zero Fahrenheit, which is higher than has been experienced generally on Greenland transections. There was a considerable amount of light snowfall and mist.

Rymill and Hampden, who crossed the ice cap from Angmagssalik to Holsteinsborg, started out August 12. The early part of this journey of 450 miles was made under good conditions and at an average daily rate of 23 miles; but after the first mountains on the west coast were sighted the surface was found badly crevassed and broken by lakes and rivers of thaw water and they did not gain the edge of the ice until September 30. The head of the Söndra Strömfjord was reached October 4, and the next day they fell in with an Eskimo umiak that had been sent out for them by the Danish governor at Holsteinsborg.

Watkins himself with Lemon and Courtauld, using two fifteen-foot whaleboats equipped with outboard motors, started down the east coast on August 15, 1931. For the first 140 miles the coast was surveyed by plane table with astronomical checks of position and with the higher peaks also located from the ice cap by Scott's party. One result of this survey was the discovery of an island to the northward of Umivik which was forty miles long and had two independent ice caps on it.

Some of the outstanding geographical results of the expedition were the discovery from the air of a higher range of mountains about fifty miles north of Kangerdlugssuak with peaks estimated to reach 12,000 to 14,000 feet of altitude; the surveys of the region near Mt. Forel, the preparation of survey maps of the Kangerdlugssuak, and the area about the main base, as well as the east coast region from Ikerssuak to Umivik Bay.

During the entire expedition seventy-four airplane flights were made which totaled eighty-six flying hours. With the exception of the stretch from Cape Dan to Björne Bay the entire coast was photographed from the air from Umivik, 140 miles to the south of Angmagssalik, to Kangerdlugssuak, more than 250 miles to the northward—a very remarkable achievement and one that proves conclusively the adaptability of this method of surveying for the Greenland area.

As regards the possibilities of Angmagssalik for a flying station on the transatlantic route, the sea surface is entirely unavailable on account of floating ice in rapid movement. However, two lakes, one at Angmagssalik in position 65° 40′ N., 37° 32′ W. and one at the head of "Lake Fiord" in position 66° 21′ N., 35° W., are both suitable for the largest types of flying boats and seaplanes, except for about five weeks in the autumn, during which the lakes are acquiring a firm cover, and about six weeks in the spring, during which the lake ice is breaking up. Flight Lieutenant D'Aeth states, however, that, apart from the gales and in spite of the short days, winter flying conditions are good. There is little snow and practically no fog, and the temperature on the coast seldom falls below zero. There is almost always some fiord smooth enough to land on in case of a forced descent; and, if a landing did have to be made, it would be possible to walk to some inhabited place if the necessary emergency rations and camping gear were carried. Long-distance flights alongshore to or from any one base on the coast are out of the question on account of the prevalence of the föhn

gales, which are to be dreaded rather because of the drift snow, which reduces visibility, than because of the strength of the wind.

While the expedition was without aerological equipment, the many journeys over the ice cap gave observations of value in connection with the characteristic air circulation of a continental glacier—the glacial anticyclone. The dominance of the centrifugal surface winds, the light and variable wind currents near the crest of the ice dome, and the fierce blizzards of the slope region, described by all earlier expeditions, found ample confirmation. Likewise the fading out or disappearance of this circulation at short distances outside the ice margins, with consequent astounding local differences observed within the coastal area, was emphasized.

At the ice-cap station air temperatures (September-May) were always below freezing (maximum, −29° F.; minimum, −64° F., in March) and precipitation always in the form of snow. The lightest wind would raise fine snow powder and make visibility bad, but in many cases it could be observed that the drift snow was a shallow layer seldom more than ten or fifteen feet in thickness, so that an airplane could probably land though with difficulty.

A new observation was the great temperature inversion over the interior of the ice cap at elevations of 1000 to 1500 feet above the ice surface. Flights were made over the ice cap in all months of the year except June, July, October, and November; yet at no time was a lower temperature than −14° F. recorded.

Comparison of barograms made at the main base and at the ice-cap station brings out strikingly the frequency of gales at the former and their general absence at the latter (though winds of force 4 to 7 were more frequent at the ice-cap station). During the period of simultaneous observation there were thirty-three days with gale at the base, of which only seven were days of gale at both stations. There were only two days with gale at the ice-cap station on which gales were not experienced at the base. Eighteen of the gales at the base exceeded force 10, eleven of them force 12; whereas the maximum at the ice-cap station was 9. Moreover at the ice-cap station the gales were not dominantly from any one direction whereas at the base the majority were from the north and were of the usual föhn type (see S. T. A. Mirrlees: The Weather on a Greenland Air Route, *Geogr. Journ.*, Vol. 80, 1932, pp. 15–30).

W. H. Hobbs

Postscript. News comes from Greenland (Aug. 24) of the tragic death of H. G. Watkins at the age of 25 years. He was drowned in a kyak accident in Lake Fiord where the base camp of his 1932 expedition was established. The results of the British Arctic Air Route Expedition, for which he had just received the Founder's Medal of the Royal Geographical Society, are a remarkable memorial to the young leader.

Danish and Norwegian Expeditions in East Greenland 1931 and 1932. The four numbers of *The Polar Record*, the journal of the Scott Polar Research Institute, that have appeared up to date give an impressive picture of current scientific activity in the Arctic regions. A part of this is to be accounted for by the International Polar Year program but even so the expeditions are many and varied. In Greenland H. G. Watkins' expedition to Angmagssalik is continuing work under J. R. Rymill since the death of the leader (see above); Dr. J.-B. Charcot is directing the French Polar Year Expedition to Scoresby Sound; the Fifth University of Michigan Expedition has established a station in northwest Greenland; Captain Bartlett has taken a party on the *Morrissey* to erect a monument to Peary at Cape York. Intensive Danish and Norwegian exploration is in progress in East Greenland, under the stimulus of the territorial dispute (see pp. 691–693 of this *Review*).

Following up earlier work in 1926–1927, 1929, and 1930 Dr. Lauge Koch is now in charge of a "three-year program," 1931–1934, with both summering and wintering

parties in the field. The aims include "investigation of the possibilities of future Eskimo colonization" as well as mapping, geological, biological, and hydrographic work (*Polar Record*, July, 1931, p. 50). The personnel for the current season's work includes in addition to the leader and a surgeon, 13 geologists, 12 topographers, 6 zoölogists, 4 botanists, 2 archeologists, and 8 aviators (*Polar Record*, July, 1932, pp. 55–57). There will be five parties in the southern area, King Oscar and Franz Josef fiords, and four parties in the northern area, Clavering Island-Hochstetter Foreland. The expedition has two seaplanes, and aerial mapping is to be a special feature of the summer's work. The results of the Dr. Koch's expeditions are appearing in the *Meddelelser om Grønland* (Copenhagen). Another Danish expedition, led by Ejnar Mikkelsen, founder of the Eskimo colony on Scoresby Sound, plans to map the coast between Cape Dalton and Kangerdlugssuak: while Knud Rasmussen is leading the Seventh Thule Expedition in southeastern Greenland.

The Norwegians have followed an expedition to East Greenland under Anders K. Orvin in 1929 by expeditions under Dr. Adolf Hoel in 1930 (see Anders K. Orvin: Exspedisjonen til Jan Mayen og Øst-Grønland, *Norsk Geogr. Tidsskrift*, Vol. 3, 1931, pp. 367–389), in 1931 (*Polar Record*, Jan. 1932, pp. 17–18), and this current year. Surveying and hydrography have an important part in the scientific program, geological and biological studies have also been pursued, and material has been carried to hunting parties in the area. Three scientists accompanied the hunting expedition of Finn Devold to southeastern Greenland in 1930. The results of the Norwegian expeditions are appearing in the publications of the Norges Svalbard-og Ishavs-undersøkelser (Oslo).

A noteworthy feat in 1931 was the crossing of Greenland by two young Norwegians, Arne Høygaard and Martin Mehren from Kamarujuk glacier on the west coast to Waltershausen glacier on the east. Their story, with map, is told in "Tvers over Grønlands Innlandsis" (*Norsk Geogr. Tidsskrift*, Vol. 4, 1932, pp. 1–14: with comments by A. Maurstad, pp. 15–18, and Olaf Holtedahl, pp. 19–20).

WORLD AS A WHOLE AND LARGER PARTS

The Tundra and Forest Zones of Russia. The peculiar structure of Russia, combined with its vast east to west extent from Cape Dezhnev, 169° 3′ W., to 26° 10′ E. in the Ukraine, is remarkably favorable to zonal studies. Dokuchaiev's pioneer effort at a synthesis based on soil unity under similar climatic conditions was directly inspired by the great steppe zone of Russia. L. S. Berg, in an introduction to "Geographical Landscape Zones of the U. S. S. R." (Part I, Moscow, 1931), uses the term "landscape" to indicate a geographical synthesis. Yet his subsequent studies of the tundra and forest zones, which form Part I of the series, are rather of a series of separate articles on boundaries, subdivisions, flora, fauna, climate past and present, population, and tribal subdivisions. Perhaps this was inevitable in treating of such vast areas; tundra and semi-tundra occupy more than three million square kilometers (14 per cent of the whole U. S. S. R.), and podzol with marsh occupies more than eleven million square kilometers (52 per cent).

Berg's book, however, will be indispensable for all future students of the tundra, *taiga*, and mixed forest zones. It summarizes the many recent studies of these regions and gives copious bibliographical references to German and Russian sources; its author's profound and intimate knowledge of past and present climatic, soil, and vegetative conditions and his original and suggestive approach to many aspects of life in these regions give it a peculiar value. Inevitably some things are omitted on the human side; no mention is made of the effect of recent human activity in pushing southward the limit of tundra by tree cutting on the thinner northern forest fringe where tree life cannot regenerate. Against this must be set the brilliant account of the varying ecological associations that result when man destroys the

taiga forest by fire. From an economic point of view the main outlines of human life in the tundra are well given. But there is no picture of how societies adapt themselves to their adverse environment such as the sociograph that Miss L. Garrard gives of the Kolymans of Yakutia (p. 81 of "Studies in Regional Consciousness and Environment," 1930). The nearest approach to this is the reference to the Samoyede names for the months on page 92—January, "axe-forest"; February, "cold"; March, April, May, names connected with the calving of the reindeer; July, "mosquitoes"; November, "dark."

I. I. Mainov's article in "Yakutia" (Leningrad, 1927) forms a useful supplement to Berg in this respect. Physical type, social activity, movements of peoples, classes of Russians entering Yakutia, racial crossings between Russians are discussed. Two maps indicate the distribution of Yakuts, Tungus, Lamuts, Yukaghirs, and Russians in 1676 and in 1897 show the expansion of the Yakuts in the southwest at the expense of Tungus and Lamuts and in the northeast at the expense of Yukaghir. This was undoubtedly related to the introduction of agriculture into the region round Yakutsk and Olekminsk by the exiled Skoptsi in the sixties of the last century and to the more ready adoption of agriculture by the Yakuts. But soil conditions are an essential for agriculture, and Berg (*op. cit.*, p. 153) discusses the nature of the soil in this region—a lightly carbonized loess-like clay on one of the terraces of the Lena, recalling the chernozem of the steppe though having a far less humus content or depth. An important article by A. G. Rzhonsnitskiy (*Bull. Moscow Soc. Nat. Res. Geol.*, Section 6, Vol. 2, 1928, pp. 131–145) claims that the Lena terraces were formed in the latter half of the Quaternary. The evidence from soil and from plants seems to indicate a former extension of steppe climatic conditions into this area. These soils are favorable to agriculture if quickly ripening varieties of seed are used so as to avoid damage from late spring or early autumn frosts. A curious point is that the permanently frozen subsoil here helps agriculture by supplying moisture in times of drought. Berg and others consider this frozen subsoil to be a relict of the glacial epoch.

In several places Berg refers to the greater prevalence of ultraviolet rays in northern areas and to their beneficial effects on plant and animal life; Kalitin, in *Priroda*, 1929, claims to have carried out experiments proving that ultraviolet radiation in Russia north of 60° is greater than in Davos. The long duration of daylight also favorably affects plant life. A table shows that oats and wheat take 123 days to grow and ripen in Kherson and 98 days in Archangel. This may partly depend on the above factors as well as on seed selection.

In dealing with the forest zone and especially with the mixed deciduous and coniferous region, Berg treats very fully some aspects of human life. The origin and persistence of the three-field system of agriculture are discussed; and a map of its southern limit, based on Chayanov's 1910 study, bears out the suggestion that it was related to the difficulty of following winter sowing by spring sowing without a fallow year owing to the late date of harvesting. An interesting study is that of house types in the forest area, illustrated by numerous photographs and plans. This is a subject to which little attention has been given, and Berg's suggestive account of the reasons for and distribution of such curious constructions as a 17-windowed *izba* or the summer and winter *izba* connected by a vestibule is most welcome. Such a study brings out the relation of man and his environment in an unexpectedly detailed way.

R. M. FLEMING

GEOGRAPHICAL NEWS

Atlas of the Historical Geography of the United States. The Carnegie Institution of Washington and the American Geographical Society announce the publication of an "Atlas of the Historical Geography of the United States," by Dr. C. O. Paullin.

The Atlas embodies the results of twenty years of original research. In its preparation the collaboration of a large group of specialists in American history and geography has been enlisted. Introductory plates illustrate the natural environment of North America as a setting for the growth of the nation. These are followed by maps covering exploration and the development of cartographic knowledge of the area comprising the United States as well as the history of relations with the Indians. To the advance of settlement, to the changing character and composition of the population, to territorial questions, and to boundary disputes much attention is devoted. Comprehensive series of maps cover religious and educational history and the progress of reform movements. Changes in political sentiment region by region are disclosed on maps illustrating the votes in all Presidential elections, 1788–1928, and the votes in Congress on thirty-six important measures, 1790–1930. Industries, transportation, commerce, and the distribution of wealth are all mapped for different periods. The Atlas concludes with maps illustrating the military history of the United States and the possessions and territorial claims of the nation in various parts of the world.

An extended explanatory text forms an integral part of the Atlas, and there is a full index. The Atlas includes more than 620 maps and 145 pages of text. A more detailed account of the Atlas will be found in the July number of the *Geographical Review* (see above pp. 354–360).

OBITUARY

John Walter Gregory. Professor John Walter Gregory was drowned on June 6 by the overturning of his canoe in a Peruvian river. This happened in the notorious rapids of the Pongo de Mainique on the Urubamba, down which he had embarked for a study of the structural features of the Peruvian Andes, an arduous journey for one in his sixty-eighth year. "Certainly, a lifelong traveler in the wild places of the earth could not have selected a more imposing site for his last exit" (*The West Coast Leader*, July 26, 1932).

Professor of geology in the University of Glasgow, Professor Gregory was a provocative figure in the geographical field. His theories on various problems of earth structure roused much critical discussion and were fruitful in promoting further research. As a writer in *Nature* says: "He will be remembered for his explanation of the rift valleys of Africa, his exposition of the tetrahedral configuration of the earth, his brilliant contribution to the history of the Atlantic and Pacific basins which formed his presidential addresses to the Geological Society of London, his speculations on the history of valleys and fiords, and the startling hypothesis of the deep-seated and probably volcanic origin of the artesian waters of Central Australia" (*Nature*, June 25, 1932, p. 930. See also the obituary notice in the *Scottish Geogr. Mag.*, July, 1932, pp. 226–228).

Professor Gregory had traveled in all quarters of the globe. He was a prolific writer and the master of an alluring style, well exemplified in his narrative accounts of "The Great Rift Valley" (1896); "The Dead Heart of Australia" (1906); and "To the Alps of Chinese Tibet" (in collaboration with his son, 1924). Not all his travels, however, were undertaken for the study of physical problems. He made investigations in Cyrenaica and Angola on behalf of a Zionist organization, and he wrote on racial and population problems. It was fitting that his latest published work should be "The Story of the Road" (1931). It is reviewed by Dr. M. A. Peacock in this number of the *Geographical Review*.

Baron Nils Erland Nordenskiöld. Baron Erland Nordenskiöld died on July 5 in Göteborg at the age of fifty-five. The son of Baron A. E. Nordenskiöld, Arctic explorer and discoverer of the Northeast Passage, he was no less distinguished in his

field—the cultural anthropology of South and Central America. The essentials of Dr. Nordenskiöld's method, analysis of geographical distributions, gave his work a geographical affiliation, while his extensive field trips were productive of information on little-known areas. Thus during his last expedition to Panama and Colombia (Indianerna på Panamanäset, 1928) he visited the Cuna Indians of San Blas and made a study of their unique picture writing. In addition to several books he published an important series of monographs (in English), Comparative Ethnographical Studies. Of special interest are Nos. 1 and 2 dealing with tribes of the Gran Chaco (see note in *Geogr. Rev.*, Vol. 10, 1920, pp. 273–274), No. 4, on "The Copper and Bronze Ages in South America" and most particularly the latest, "Origin of the Indian Civilizations in South America," reviewed in this number of the *Geographical Review* by Dr. Clark Wissler. The careful and scholarly nature of Dr. Nordenskiöld's work is well illustrated in his article "The Guarani Invasion of the Inca Empire in the Sixteenth Century: An Historical Indian Migration" (*Geogr. Rev.*, Vol. 4, 1917, pp. 103–121).

Frederick Haynes Newell. Frederick Haynes Newell, a gold medalist of the American Geographical Society, died in Washington, D. C., on July 7, in his seventy-first year. Mr. Newell's contribution was pragmatic geography, the creation of a new world in the arid West. He was organizer and first director of the U. S. Reclamation Service. In the words of the inscription on the Cullum Geographical Medal awarded him in 1918, "He carried water from a mountain wilderness to turn the waste places of the desert into homes for freemen." The scope of his studies is revealed in one of his more recent publications, "Water Resources, Present and Future Uses" (1920).

J. Paul Goode. Dr. J. Paul Goode, Professor Emeritus of geography in the University of Chicago, died on August 5 in his seventieth year. Dr. Goode was foremost a teacher, as deeply interested in his students as in his subject, and his geographical contributions were largely on educational lines. He will be remembered for his school atlas, 1923 (see *Geogr. Rev.*, Vol. 15, 1925, pp. 168–169) and revised and enlarged edition, 1932, and his physical and political wall maps (see *Geogr. Rev.*, Vol. 5, 1918, pp. 87–88), both pioneer works in the field of modern American educational geography, and for his series of base maps and graphs. His new arrangements of projections have been widely used, especially the interrupted homolographic and homolosine projections (see "The Homolosine Projection: A New Device for Portraying the Earth's Surface Entire," *Annals Assn. of Amer. Geogrs.*, Vol. 15, 1925, pp. 119–125; see also "The Polar Equal Area: A New Projection for the World Map," *ibid.*, Vol. 19, 1929, pp. 157–161). As president of the Association of American Geographers, 1926, he spoke on "The Map as a Record of Progress in Geography" (*Annals*, Vol. 17, 1927, pp. 1–14).

Professor Goode also had strong civic interests. He took an active part in the Chicago Geographic Society; he served on the Chicago Harbor Commission in 1908; and he prepared a preliminary regional analysis, "The Geographic Background of Chicago" (1928), and directed the construction of a base map for the Chicago Regional Planning Association.

GEOGRAPHICAL REVIEWS

Political Geography of Polar Regions

Gustav Smedal. **Acquisition of Sovereignty over Polar Areas.** 143 pp.: maps, bibliogr., index. Translated from the Norwegian by C. Meyer. *Skrifter om Svalbard og Ishavet No. 36*, Oslo, 1931.

The dispute between Denmark and Norway over the sovereignty of Greenland has brought forth the valuable treatise on political geography which is here under review. Following R. N. Rudmose Brown the author defines the polar regions as the areas in the northern and southern hemispheres that lie respectively north and south of the limit of timber. With the arbitrary exclusion of the northern coasts of the North American, European, and Asiatic mainlands the northern polar regions include Novaya Zemlya, Franz Josef Land, Spitsbergen, Greenland, and other Arctic islands; and the southern polar regions include the Antarctic Continent and adjacent islands such as Graham Land, the South Shetlands, South Orkneys, South Georgia, South Sandwich Islands, Bouvet, Crozet, Kerguelen, Macquarie, and Peter I islands.

Political interest in polar regions has greatly increased of recent years, for general attention has been directed to the economic importance of these areas as hunting grounds (whaling, sealing, etc.), and in regard to metals and minerals (e.g. coal in Spitsbergen); and, last but not least, the polar regions have gained a new significance through the development of aerial navigation.

The author of this treatise defines sovereignty in the following terms: "By sovereignty over a territory is meant the authority of the State to have control of, or to rule over, the territory and the persons and objects present there. Within the territory the State exercises its legislative power, its administration of justice, and its administrative authority. As a rule it has also the right to oppose the authority of foreign states on the territory. The State has to a considerable degree the right to control access to the territory, and it generally has the right to reserve to itself and its citizens the use and exploitation of it." Sovereignty, however, carries obligations and duties as well as rights, paramount amongst them the obligation to protect the rights that other states or their nationals may possess or have acquired within the territory in question.

The memoir exhaustively discusses the means whereby a state may acquire sovereignty over a former "no man's land" and, having acquired it, how it may be effectively exercised and maintained. Sovereignty may be acquired by treaty, e.g. the Spitsbergen Treaty of 1920, or by effective occupation. The doctrine of occupation raises many difficult and much discussed questions of international law. While questions of a special nature arise in regard to polar regions, Smedal thinks that the rules governing occupation in other parts of the world should apply in general also to polar regions.

Smedal concludes that no occupation, whether by treaty, proclamation, flag-raising at boundary points, scientific or other expeditions, or establishment of wireless stations, should be regarded as valid unless there is also effective possession, control, and administration, which of course is a very difficult matter in polar regions. As a good example of the effective possession of polar areas he cites approvingly Canada's handling of the Arctic islands lying north of her coasts.

The sector principle is next taken up. The idea seems to have been first promulgated by P. Poirier, a Canadian senator. Roughly speaking, it means that a nation whose territory borders on the polar regions has a right to the sovereignty

of all the areas between its northern (or southern) coast line and the pole. In illustration of this conception two maps are published, one showing the north polar regions with the Alaskan (or United States), Canadian, Danish (Greenland), Norwegian (Spitsbergen), Finnish, and Soviet Union sectors. In the south polar regions only two sectors have been claimed, both by the British, namely the Falkland Islands Dependency and the Ross Dependency.

The United States has never claimed any sector, and in any case the sector principle gives the United States no advantage in north polar regions since no land has yet been discovered between Alaska and the north pole. In the Antarctic the opinion is expressed by Dr. Smedal that Great Britain has sovereignty only over the lands it has taken effective possession of—which certainly do not include any part of the Antarctic Continent. The United States is likely to contest, and has indeed contested, some of the British claims in Antarctica, especially since Admiral Byrd's flight. Claiming new lands because they have merely been flown over is, however, no more justifiable than claiming them because they have been seen from a ship out at sea. The British claim to King Edward VII Land was based on the fact that its coast was seen by Captain Scott in 1902; but this coast was first actually landed upon by a Norwegian expedition in 1911. As a Scottish newspaper well said, on these grounds a nation might with equal justification claim the moon.

Nearly half the memoir is taken up with the dispute between Denmark and Norway over East Greenland. Norway claims that East Greenland up to 1924, with the exception of the Danish station of Angmagssalik, was a "no man's land" and that Denmark, which claims the whole vast area of Greenland (2.2 million sq. kms.) has only taken effective possession of West Greenland from Cape Farewell to latitude 73° N. In the course of the discussion such geographical matters as Danish and Norwegian industry in East Greenland, the economic importance of the country, scientific expeditions and explorations, and colonization are fully dealt with. The question of sovereignty is still undecided. Norway has claimed sovereignty over a part of East Greenland, and the whole matter is now being adjudicated upon by the Hague Court.

This able memoir represents a valuable contribution to political geography. It maintains a considerable degree of impartiality notwithstanding that it has obviously been written to uphold the Norwegian claims in East Greenland.

G. W. TYRRELL

DANISH AND NORWEGIAN CLAIMS IN GREENLAND

JOHN SKEIE. **Greenland: The Dispute between Norway and Denmark.** 94 pp.; maps. J. M. Dent & Sons, London and Toronto, 1932. 7½ x 5 inches.

Since the publication of the memoir by Gustav Smedal, reviewed above, the dispute between Norway and Denmark over East Greenland has become acute. Norway, alleging aggressive action on the part of Denmark, has officially proclaimed sovereignty over two areas on this coast—in July, 1931, over a tract from 71° 30′ N. to 75° 40′ N., named for Eric the Red, who first sighted a part of the east coast in 870, and in July, 1932, over a tract between 60° 30′ N. and 63° 40′ N. The growing bitterness is reflected in this little book, a statement of the Norwegian claims by Professor Skeie, deputy judge of the Supreme Court of Norway.

Professor Skeie presents the historical argument, involving the relations between Norway and Denmark from their union in 1380, discusses the more recent political and legal acts bearing on sovereignty, and criticizes the monopoly policy of Denmark in Greenland. He cites the extensive use of the east coast and its waters by Norwegians since the establishment of sealing there by Svend Foyn in 1847 and makes the point that profit in the ventures often depends on the supplementary catch, walrus, polar bear, musk ox or on salmon fishing. Here the reader may also be

referred to Major Gunnar Isachsen's writings on the subject, the most recent of which is "Norske fangstmenns og fiskeres ferder til Grønland 1922–1931" (*Norsk Geografisk Tidsskrift*, Vol. 4, 1932, pp. 21–74). Professor Skeie enumerates the expeditions which have taken part in the exploration of the east coast and emphasizes the services of Norwegian skippers and trappers to scientific expeditions.

The maps in the volume include one showing the Norwegian and Danish "houses" (hunting stations) between Scoresby Sound and Germania Land, a reproduction of Figure 4 in Smedal's memoir with the addition of the name "Eirik Raudes Land" and its limits and the "main line for Danish exploratory work 1931–33."

The problem of this disputed territory in which geography plays so large a part is many-sided, and the decision before the Hague Court will not be easy, as no doubt will be more evident still when publications appear that present the Danish side of the case. Nevertheless it is urgent, if only that adequate protection may be assured the industry on which occupation of the region depends. The needs of the conservation of wild life were pointed out by Wordie several years ago (The Cambridge Expedition to East Greenland, *Geogr. Journ.*, Vol. 70, 1927, pp. 225–265; reference on p. 237).

The New Turkey

Eugène Pittard. **A travers l'Asie-Mineure: Le visage nouveau de la Turquie.** 312 pp.; maps, diagrs., ills. Société d'Éditions Géographiques, Maritimes et Coloniales, Paris, 1931. 9 x 5¾ inches.

This book presents a summation of the observations and experiences made by the author during a study tour through western and southern Asia Minor in 1928. Pittard is curator of the ethnographic museum of Geneva, and his story and conclusions pertaining to the history of the Turks are interesting in themselves and as illuminating problems of today. He also gives the reader a comprehensive survey of the various aspects of the natural landscape and the daily life of the people and brings out the relationships from direct and dependable sources. Through intimate contacts with central and local authorities he has obtained the basis for deductions as to political and economic conditions, often statistically presented.

Pittard asserts that the Turkish people exhibit unity of anthropologic type but that many offshoots occur from it. Although the people of modern Turkey are derived from heterogeneous elements, and several ancient tribes have descendants in Asia Minor, they are all more or less amalgamated. They have adopted the language brought into Asia Minor by the Turks, Seljuks, and Ottomans, and they have also, partially at least, accepted the religion and material culture of the Turks. In similar manner, according to Pittard, the numerous early Greeks of Asia Minor were only in a small degree of direct Greek descent. The majority consisted of descendants of older peoples who had become Hellenized by a few Greek invaders.

It is indisputable, however, that the Turkish people now exhibit unity anthropologically as well as culturally and linguistically. It is of interest to note how Pittard esteems these people in intellectual and moral respects. "Whatever their carping critics may say, the Turks nevertheless belong to the world's choicest racial group. All who have traveled through Turkey praise their simplicity, honesty, and hospitality." He quotes and endorses Réclus: "When the Turk is not corrupted by power or stupefied by oppression, he is, thanks to a complexity of good qualities, a most delightful individual. He is never deceitful but always honest, sober, and truthloving. He is ridiculed, moreover, for these qualities by his neighboring Syrians, Greeks, Persians, and Armenians. He is in a fine sense socially minded, always willing to sacrifice for others and never demands sacrifice for himself. . . . Every traveler into inner Turkey is touched by the friendliness with which the stranger is greeted. . . . The tolerance of the Turk is without bounds . . . "

My own experience confirms the judgment expressed by Pittard and Réclus. I

often met Anatolian farmers some distance from town, and they invariably greeted me, a stranger, most heartily and invited me to their homes. Honorable and pleasant, energetic, hospitable, and tolerant—such are the people whom Mustafa Kemal has organized into modern Turkey.

Pittard concludes his analysis with the statement that the western nations have not only erroneously but wholly unjustly judged the Turkish people, for reasons to be sought in the earlier Christian intolerance. Unconsciously we carry on the Crusaders' antagonism against the Byzantines.

As already stated, Pittard presents a careful summary of the industrial geography of Turkey, amply supported by statistics. He gives special attention to the economic significance of the emigration of the Grecian groups from Asia Minor. In some quarters it has been said that this migration has lost to Turkey its most energetic citizens, that manufactures of Turkish rugs have declined, that production of subtropical fruits in western Anatolia is declining, etc. Before the Grecian emigration the carpet-weaving industry in the Smyrna district utilized 8290 looms and employed 24,250 workers, of whom 20,550 were Turks and the others Greeks and Armenians. In 1926 there were 11,305 looms in operation employing 30,490 workers, all Turks, and output had increased 20 per cent. In agriculture it is true that the decreased man power brought about by the Grecian emigration caused a temporary decline in western Anatolia of some products (figs, grapes, tobacco), but the production curve later steadily rose and has probably attained about the level it had ten years ago.

Forests occupy about one seventh of the total area. The largest and most valuable (about a million hectares) occur in the districts north of Ankara along the Black Sea and consist chiefly of spruce and pine. Near Janik they are almost as large and are about evenly divided between pines and broad-leaved species. In former times the forests were much more extensive. Herodotus speaks of vast forests in the interior of Asia Minor, but these were destroyed later by Romans, Greeks, and the Turks. The present régime has undertaken as a major enterprise the difficult but important project of reforestation.

The pronounced change the Turkish nation has undergone in a decade in material and cultural progress, in economic status, and in political significance is due wholly and entirely, the author says, to the fact that Turkey, in the most critical moment of its history, discovered a man of phenomenal insight—Mustafa Kemal Pasha. He and his coworkers are indispensable to the welfare of Turkey.

JOHN FRÖDIN

EPIC OF THE ROAD

J. W. GREGORY. **The Story of the Road, from the Beginning down to A.D. 1931.** xii and 311 pp.; maps, ills., indexes. The Macmillan Co., New York, 1931. $4.00. 8¾ x 5½ inches.

This unusually enjoyable and instructive book, the last from Professor Gregory's pen, takes the reader swiftly to the ends of the earth and through the depths of time from the paleolithic to the present and leaves him with a vivid impression of geography and history bound into a coherent unity by a system of living roads. Architectural monuments of the past give us points, so to speak, in the geography-history record of human development; but roads in constant use for thousands of years, such as the buffalo trails of the United States, followed by the Indians, then by the wagons of the pioneers, and finally by the road and railway builders of the present; or the "harrow-way" or "holloway" of Willersey Hill on the border of Gloucestershire and Worcestershire, sunk ten feet into hard oölitic limestone by continuous use estimated to extend from 10,000 to 2000 B.C., give us illuminating lines affording even more impressive testimony to the continuity of man's activity and development.

Ancient monumental architecture, furthermore, usually represents work of special nature undertaken by autocratic rulers in times of prosperity and abundant slave labor; roads, on the other hand, indicate much more nearly the everyday business of the people who made and used them. Primitive man traveled mainly in search of food, and consequently the trails trodden out by animals in the same activity served his purpose. The sinuous footpaths of the African jungle, still meandering around natural obstacles which may long since have decayed and disappeared, are simply game tracks adapted to human use. With the beginning of extensive barter between people widely separated came the caravan trade routes by which lapis lazuli was carried from northeastern Afghanistan to Egypt in the Neolithic, amber from the Baltic to the Mediterranean in the Early Bronze Age, and silk from China to the Near East in the last centuries before the Christian era.

Under imperial governments came better and safer roads, such as the Royal Road of Persia with its stations and fortified gateways described by Herodotus; the military roads of Carthage which were, contrary to current belief, probably not paved; the splendid paved roads of the Roman Empire; the imperial roads of China with their broad-treaded stairways leading over mountain passes; the Inca roads of Peru, wide and paved, evenly graded, and provided with fine bridges, tunnels, and embankments to carry them without steep inclines through mountain country; Napoleon's monumental roads across the Alps; and General Wade's military roads in Scotland. Under the governments of the present were built state-subsidized roads such as the national roads of the United States, broad and straight and decorated with signposts and stations for the refreshment of man and his modern beast of burden.

In addition to a description of ancient and modern roads Professor Gregory's book discusses road construction and road materials, including recent experiments in the use of a rubber carpet, the evolution of vehicles, the history of road administration, technical problems of road building and maintenance, and such up-to-date problems as the competition of motor transport with the railways.

With information gleaned from a long list of writings on roads, ancient and modern, literary, scientific and technical, together with a fund of significant observations and reflections arising from many seasons' travel on the highways and byways of most of the countries of the world, Professor Gregory has produced a valuable contribution to human geography. The general reader will find a scholarly and literary picture of the geography and history of roads, while the student will in addition find the means of pursuing this fascinating subject by way of the large number of references to special studies.

M. A. Peacock

Central and Southeastern Asia After Ptolemy

André Berthelot. **L'Asie ancienne centrale et sud-orientale, d'après Ptolémée.** 423 pp.; maps, bibliogr. Payot, Paris, 1930. 60 frs. 10 x 6½ inches.

Like M. Berthelot's "L'Afrique saharienne et soudanaise," the present work is a most careful and exhaustive study of the subject it deals with. In its composition the author has availed himself not only of classical Greek and Latin sources but of Chinese accounts as well. He makes little use of conjecture and displays commendable caution in his identifications of places mentioned by Ptolemy.

First he tells what is known of the early Indo-Europeans. He enumerates the geographical and other indications regarding the location of their original home: "These are in harmony with the hypothesis that places it at the foot of the Tien Shan, in the country of origin of the domestic horse" (p. 24).

The majority of modern investigators, it is fair to say, appear inclined to look for the "Aryan cradle" rather farther to the west, in the regions north and north-

east of the Caspian. Nevertheless the author's account of the undivided Indo-Europeans is quite one of the best that has appeared thus far. He also discusses in the same part of his book the vastly important rôle played by the Persian Empire in the diffusion of culture, both east and west; and he gives a good account of the geography of Strabo.

The second part of the book is devoted mainly to a study of Ptolemy's great work. The theoretical basis on which he worked out his projections is fully discussed, the author pointing out incidentally that his longitudes were founded not on astronomical data but on measurements or estimates of distance. M. Berthelot also notes the immense progress made in depicting the face of the earth in the interval between the compilation of works like the *Orbis Pictus* of Agrippa, in the time of Augustus, and the maps of Ptolemy, a contemporary of Hadrian.

In the third and fourth parts of his book, M. Berthelot deals with Ptolemy's descriptions of central and southeastern Asia. He does not, however, confine himself to a discussion of the extent of the information thus disclosed but describes also the historical process through which that body of knowledge was acquired in the course of centuries of commercial and military enterprise.

The author is hardly justified in stating, in the third part of his book, that the history of China began only in the twelfth century before Christ, for there are inscriptions, on bone or tortoise shell, which push it back at least a century or two earlier. He is quite right, however, in dismissing as untenable the theory that civilization in China originated independently, in the eastern plains of that country. He points out also the really surprising knowledge of China displayed by Ptolemy—the remarkable accuracy, for example, of his location of the sources of the Yellow River.

In the fourth part of his book the author shows how exact was Ptolemy's information regarding the coastal region of India and how he nevertheless was led to distort the shape of that peninsula. He also notes the striking contrast between Ptolemy's knowledge of the southern coast of Asia as far as Tonkin and perhaps even slightly beyond, on the one hand, and, on the other, his total misconception of the regions still farther to the east. This difference in his comprehension suggests that voyages to the eastward of Indo-China had only begun to be made not long before Ptolemy's time and that their significance had not yet been grasped. It seems probable indeed, on quite other grounds, that sea-going sailing ships began to penetrate to southeastern Asiatic waters only about the beginning of the Christian era.

Ptolemy's curious distortion of the eastern Asiatic coast may quite probably have been due, as M. Berthelot suggests, to the southward projection of the Lei Peninsula. If so, voyagers can hardly have gone very far east of the latter, or they could not have failed to note the real trend of the land to the northeastward. Yet our author denies categorically that the mysterious Cattigara had anything to do with Kiao-chi and points out that Ptolemy is in agreement with Marcian of Heraclea (hardly an independent authority) in locating it far within the Chinese borders. M. Berthelot's own suggestion is that it was identical with the famous medieval port of Zayton, not far from the present Amoy. Certainly Ptolemy, as his own words show, was aware of the marshy, water-logged nature of the coast north of the Yangtze, hundreds of miles beyond Amoy. That Thinai, the metropolis of the Sinae, or people of southern China, was Ying, the capital of the ancient Yangtze River state of Ch'u, is hardly probable; for Ying ceased to be the capital of Ch'u in 278 B.C., four centuries before Ptolemy's time.

M. Berthelot clearly demonstrates the wide extent and the substantial, in some instances indeed remarkable, correctness of Occidental knowledge concerning remote Asiatic lands early in the second century of our era. Under the Eastern Han Dynasty, which was ruling China as well as much of Inner Asia during that period, the trans-Asiatic caravan routes were available to travel somewhat as they were a thousand

years later, in Marco Polo's time, under the Mongols. Moreover, the great improvements in shipbuilding and navigation which were being made around and soon after the beginning of the Christian era led, as we know, to a great extension of voyages along unknown coasts and even across the open sea, not unworthy of comparison with those of the Portuguese in the time of Henry the Navigator. Records of the explorations made in antiquity, both by land and by water, have in nearly all cases been lost: indeed they were rarely made public even at the time. Nevertheless, as our author shows, Ptolemy's knowledge of central and southeastern Asia proves conclusively that those regions were then actually being visited by men from the West.

There are sixteen maps, including one in color at the end; all are clear and greatly help the text. The author's plan of displaying Ptolemy's geographical conceptions side by side with our modern ones is most happy. The book contains a good bibliography as well as a carefully arranged table of contents; the latter, however, is very far from supplying the place of an index.

"L'Asie ancienne" is an admirable piece of work. M. Berthelot writes in a clear, delightful style, and his book displays throughout a rare union of deep erudition and sound common sense. It will be indispensable to all who are interested in the knowledge of Asiatic lands attained by the ancient geographers.

C. W. Bishop

South American Indian Origins

Erland Nordenskiöld. **Origin of the Indian Civilizations in South America.** With appendixes by Stig Ryden, Axel Hultgren, G. Phragmen, and Karl Izikowitz. Maps, ills., bibliogr. *Comp. Ethnogr. Studies No. 9*, pp. 1–153, Göteborg, 1931.

Baron Erland Nordenskiöld, the author of these studies, died July 5, 1932. Hence, it is fitting that this brief review should acknowledge his many contributions to the anthropology and geography of South America. For many years he gathered data upon the distribution of culture traits in aboriginal and prehistoric America, and was for long recognized an authority in this field. His main objective was to use the method of geographical distribution as a means to the formulation of judgments as to places of origin for each trait in question.

The current issue of his well known series of Comparative Ethnographical Studies, while using the same geographical method of procedure, yet concerns itself with the old puzzle as to the direct transfer of such traits from Oceania and Asia to America, and it is to this, the main paper in the volume, that this review pertains.

The argument is organized under the following heads: Migrations from North America to South America; "Oceanian" culture elements in South America; Do the higher civilizations of ancient America owe their origin to Asiatic influence?; Cultural interchange between the higher civilizations of Central and South America. Since the first and last of these headings are logically related, it may be that the author was more concerned with the spread of culture within the New World than with possible transoceanic movements. Thus he calls attention to the lack of evidence for the migrations of peoples from one American continent to the other. No linguistic stock is common to the two continents if the dividing line is drawn at Panama. Curiously enough, the West Indies seem to have been subject to incursions from South America, but between these islands and Florida was another dead line. On the other hand ideas and inventions did pass from one continent to the other; assuming, that is, they were not invented independently. Respecting the Central American and Peruvian highlands, the author lists the important traits peculiar to each as well as those in common. Among those for Peru not found anywhere in Central America are: the llama, guinea pig, musk duck, potatoes, coca, quinoa, oka, steelyard, beam scale, spiked war club, holed metal ax, copper welding,

soldering with silver, etc.—thirty-nine in all. Among those peculiar to Mexico and Central America not known in South America are: cochineal, cacao, turkey, stone pillars, cantilever arch, mortar of burnt lime, clubs with obsidian flake edges, coolie yoke, dolls with jointed arms, writing, a calendar, sign for zero and minus, dated monuments, paper, etc.—twenty-nine in all. Evidently communication between the highlands of South America and those of Central America was fitful, otherwise so many important inventions could not be so listed. In the matter of cultivated plants South America is superior, as also in the technique for working metals. Omitting further details we may note the conclusion of the author that the obvious migrations of peoples from North to South America were ancient but that a moderate interchange of inventions and ideas continued to the present. Further, the fact that certain correspondences are observed between Amazonas and Central America in contrast to Peru, suggests that ideas and inventions were exchanged between those areas.

Respecting the question as to whether culture traits were introduced from without, the author first shows that with all their differences the resemblances between North and South America are far greater than the resemblances between either and Oceania or Asia. Previous writers upon the subject have been content to point out a few striking correspondences between the Old World and the New and capitalize them. Nordenskiöld shows the weakness of this method by implication, for his is a quantitative approach. In an earlier publication he prepared a formidable list of inventions from aboriginal America not known in any part of the Old World; this at least proves that new inventions were made in America. As to the recognized correspondences between Oceania and the New World, he prepares a list of 49 such traits and then traces their distribution in America. Of this total a much greater number occur in Amazonas than in Peru; in fact, the great area for these traits is Mexico, Central America, Panama, Colombia, and Amazonas—a continuous area. Further they are not conspicuous in the higher cultures, on account of which and other reasons the author infers that if these traits came from Oceania they must have come in at a remote period. On the other hand their distributions are so spotty and casual as to suggest independent origin than otherwise. Nowhere does he find a core of Oceanic culture. Again the similarities to Melanesia are greater than to Polynesia, and in general the case for the direct transfer of these traits to America is weak.

A number of important culture traits are common to the Old and New Worlds, but at the same time are absent in Oceania. Parallels are more frequent in the higher cultures of the New World and so if transplanted from Asia must have come direct; to have carried them by way of Alaska is improbable because of environmental conditions. Some of these traits are ore smelting, casting by the cire-perdue method, bronze, gilding, parasols, litter, beam scales, teeth filling, mirror, etc.

The typological study of metal artifacts made by the author and by Rivet seem conclusive in establishing independent invention in the New World; and because of similarities in other traits it is stated that, whatever influence came direct from Asia must have reached America before the higher cultures began their initial development. And finally, "Evidently all higher civilization in America in the main constitutes an intensive development of Indian culture under favourable conditions."

The author's arguments are at times involved and a bit confusing, but with his method the reviewer has no quarrel. The value of the study lies in the careful assemblage of data and insistence upon considering differences as well as resemblances. One must not forget that verifiable observation ends with establishing the presence, absence, similarity, and differences of specific culture traits; after that one proceeds by inference and logic. Nordenskiöld's contributions on the relation of Old and New World cultures are the best available, and it is peculiarly fitting that he lived long enough to issue this general discussion of Old and New World relations. Finally,

the reviewer expresses his regret over the untimely interruption to this series of investigations and the premature closing of one of the most important current series of publications in anthropology and geography.

CLARK WISSLER

GEOTECTONIC HYPOTHESES

L. RÜGER. **Geotektonische Hypothesen.** Diagrs., bibliogr. *Geogr. Zeitschr.*, Vol. 37, 1931, pp. 577–599.

This paper sets forth in brief the fundamental principles underlying many of the geotectonic hypotheses that have been advanced. As a preliminary come discussions of the interior part of the earth, the earth's crust, isostasy, the forces acting to change the surface of the earth.

The author appears to be an advocate of isostasy, but he does not seem to have an open mind on the subject. Pratt's conception he sets aside as containing "a number of assumptions rather difficult to understand and at the present day largely abandoned." The Airy hypothesis, he says, is almost universally accepted today. This attitude of the author does not seem to be quite in accordance with the facts, for there is no direct proof, by geodetic or other evidence, that one or the other of these isostatic hypotheses is the correct one.

The geotectonic hypotheses that the author proceeds to outline are: Ampferer's theory of mountain building by magmatic flow, Mellard Reade's thermal hypothesis, E. Reyer's slip-faulting hypothesis, Haarmann's oscillation theory, C. G. Sandberg's hypothesis of thermal isostasy, Nölke's hypothesis of nuclear contraction, Daly's geosynclinal theory, Joly's expansion theory, Ruud's contraction-displacement hypothesis, Schwinner's cyclonic theory, Wegener's continental drift theory, Gutenberg's flow theory. It is evident that he gives more credit to Gutenberg's theory and ideas regarding the earth, its rigidity, density, etc., than to any others.

In conclusion Rüger observes: "There is still much uncertainty concerning the forces but more is known about the movements. The positive result reached during the past two decades is that the conception of continental migration is valid. Horizontal movements have been more and more verified by measurement, but how these movements will fit in with variations in the distances between continents (which have not been verified geodetically) is a problem still to be solved. It must still remain questionable in what manner the tectonic triad, continental wandering and mountain-building volcanism are connected with one another. Without doubt, causal relations exist but the question 'how' is unknown to us. We do not even know whether the observational material is now sufficient for a synthesis and, even if so, whether we are proceeding correctly in the grouping of the observations."

One indeed reaches the definite conclusion, after reading Rüger's article, that we are suffering from a lack of fundamental data. In the past we have tried to understand the great processes that have been acting for several billions of years by studying intensively only a few isolated regions. For instance, there are vast areas in Asia, Africa, and South America almost unexplored, geologically speaking. We do not even know the geology of our own country. We know little of the configuration of the ocean beds. The splendid work of the German ship *Meteor* in the South Atlantic, by soundings closely spaced, revealed the ocean bottoms as rugged of topography rather than the extended level plains of our preconceptions. And it is equally true that we need more topographic mapping in continental areas. The United States now has only about 44 per cent of its area topographically mapped, and therefore it is very difficult to make effective investigations of geological features in the larger part of its area.

Hypotheses may be advanced by any one who studies such fragmentary geological and geophysical data as now exist, but until more data have been collected they

cannot rest on firm foundations. The reviewer agrees with Rüger that we "still stand at the threshold of geotectonic hypotheses," and it looks as if the door were closed and its opening left to the indefinite future.

WILLIAM BOWIE

THE EARTHQUAKE HAZARD AND ITS SOLUTION

JOHN RIPLEY FREEMAN. **Earthquake Damage and Earthquake Insurance. Studies of a Rational Basis for Earthquake Insurance also studies of Engineering Data for Earthquake-Resisting Construction.** xiii and 904 pp.; maps, diagrs., ills., indexes. McGraw-Hill Book Company, New York and London, 1932. 9¼ x 6½ inches.

This book is addressed to structural engineers, insurance executives, and property owners, rather than to seismologists. It is the only book in the English language devoted to the engineering side of seismology and, as such, is a valuable contribution to the subject. It brings together much information that is widely distributed and not easily accessible.

Property owners in California are now paying more than two million dollars a year in premiums for incomplete and unsatisfactory insurance. This condition is attributed to the fears of underwriters, who lack reliable information on which to base their rates. Very few property owners outside of California seek earthquake insurance, although, if it could be obtained at reasonable cost, it would fill a position similar to fire insurance.

Most people have an exaggerated idea of the damage caused by earthquakes, largely because the published descriptions of earthquakes concentrate attention on the damaged buildings. Dr. Freeman shows that, even with the greatest earthquakes, the destruction has been confined to relatively small areas and that within these areas the ratio of loss to sound construction has been small.

In arriving at conclusions regarding the earthquake hazard, he discusses in considerable detail the frequency and violence of earthquakes in different regions but especially in the United States and Canada. It should be emphasized that only a few destructive earthquakes have occurred in North America during the relatively short period since the continent was settled by Europeans; and, where earthquake history covers so short a period, it does not furnish the necessary data for determining the relative earthquake hazard in different sections. In the opinion of the reviewer the best indication of the relative seismicity of different areas is furnished by the amount of differential displacement of the earth's surface during post-Pleistocene time.

A chapter is devoted to the relation of structural safety to the local stability of the ground. A knowledge of the character of the foundation material and the way it behaves during an earthquake is of the utmost importance in locating and designing structures. Equal space might well have been devoted to the importance of locating active faults and to the criteria by which they may be recognized.

In discussing the effects of severe earthquakes on buildings, Dr. Freeman not only reviews the published reports on the Charleston earthquake of 1886, the San Francisco earthquake of 1906, the Santa Barbara earthquake of 1925, and other important shocks, but he also gives the results of his own investigations in which he has paid special attention to buildings that were not damaged. He thinks that these undamaged buildings furnish the structural engineer with data of the greatest value. Buildings that are properly designed and well constructed have been damaged very little by any of the larger earthquakes that have occurred in the United States.

Some of the most important literature dealing with earthquake-resisting construction in Japan and Italy is reviewed, and here again the writer has had the advantage of personal visits to both countries.

Tentative estimates of the probable average earthquake-loss ratio for specific types of buildings when subjected to an earthquake of high intensity are given in the form of a table. Another table gives the expectation of average earthquake loss on various types of construction for one entire city in cents per $100.00 of sound value per year. The figures range from 0.5 cent for the best types of earthquake-resisting buildings located in the Atlantic coast states more than fifty miles from the sea and not in a region of recurrent shocks to 30 cents for concrete block or hollow-tile structures located in California within fifty miles of the coast or within fifty miles of the San Andreas fault. Seismologists may well question the propriety of singling out the San Andreas fault to the exclusion of the other active faults, and there is little evidence for assuming that the earthquake hazard is appreciably greater within fifty miles of the Atlantic coast.

The design of earthquake-resisting buildings is taken up in some detail. The literature on the subject is reviewed, and abstracts are given from several important Japanese publications. Recent research with shaking tables is described, and also the attempts to determine the actual motion of the ground during severe earthquakes. Definite recommendations are made, and figures are given for the increased cost of building earthquake-proof structures.

STEPHEN TABER

THE COAL PROBLEM

H. M. HOAR. **The Coal Industry of the World.** 328 pp.; maps, diagrs., ills., bibliogr. *Bur. of Foreign and Domestic Commerce, Trade Promotion Ser. No. 105*, Washington, 1930. $1.00. 9 x 6 inches.

The Competitive Position of Coal in the United States. xvi and 288 pp.; diagrs. National Industrial Conference Board, Inc., New York, 1931. $3.00. 9¼ x 6¼ inches.

Mr. Hoar's study is designed to determine the factors responsible for the present widespread depression in the coal industry and to point out the existing trends within the industry. This is the first time that such a wealth of material has been brought together and so treated as to be readily available to geographers.

The more important problems are due to the fact that the productive capacity of the mines has increased much more rapidly than demand. This in turn has been due to the opening up of new mines by some nations in an effort to make themselves more independent in fuel supplies; to the increased use of such substitutes as oil and hydro-electricity; to improved efficiency in the use of coal; and to underconsumption as a result of the present world-wide depression. Special attention is given to the problems of the United States, and it is pointed out that in this country the industry is in a better position than in most other important coal-producing nations.

The author first deals with the industry in the world as a whole and then takes up the individual countries. In estimating world reserves the tables compiled by the Twelfth International Geological Congress, in 1913, are used. It is unfortunate that no comprehensive post-war estimates are available because of the confusion involved in adjusting those of an earlier date to production and boundary changes. However, in discussing the individual countries the author frequently uses more recent data. The latest figures given are for 1928.

Trade in coal is fully discussed. In most cases statistics concerning both imports and exports cover a sufficient number of years to present a true picture of the situation. The statistics are supplemented by a discussion of the trade of each country, and changes in such trade are pointed out and explained.

Throughout the study the author stresses the importance of the scientific classification of coal into various grades. Where possible in his consideration of the individual countries, statistics concerning production, consumption, and trade are given on the basis of these various grades. The fact is emphasized that coal can no longer be

classified exclusively as a fuel but, because of the increasing production of by-products must also be regarded as an important industrial raw material.

A brief world survey serves as an excellent introduction to the study published by the National Industrial Conference Board and shows clearly the position occupied by the United States in the coal industry. This is followed by an analysis of the competitive energy market within the United States. The rising importance of oil, gas, and water power has caused a decline in the relative position of coal, which in 1909 accounted for 86 per cent of the total energy consumption while by 1930 its share had declined to 61 per cent.

The second part of the book deals with coal consumption in its principal uses—energy-producing and converting industries, manufacturing, transportation, mining other than fuels, and domestic use. Attention is given to the past and present fuel requirements of each and to the different types of energy used to meet these requirements. Estimates are made as to the future demands for coal on the part of these various groups of consumers.

Part three is concerned with the consumption of coal by marketing regions. Interesting data are also given concerning the changing position of the various producing fields. Past records are analyzed in an effort to arrive at an estimate of the future coal requirements of each region. This necessitates a careful consideration of substitute sources of energy; and the authors conclude that in the future increased competition from oil, gas, and water power will be largely restricted to the part of the country west of the Mississippi River. However, in the east increased efficiency in the use of fuels may prevent any marked rise in the demand for coal for some time.

The last section of the book deals with competitive problems and policies. Special attention is here given to overcapacity and its injurious effect on miners and operators. This problem is closely linked up with mechanization, as continuous operation is essential if machines are to be used profitably, while excess capacity and seasonal demand make such continuity impossible. The decrease in the number of mines and the increasing share of production coming from the larger ones is viewed as an improvement; but some sort of control is regarded as essential if the problems arising from excess capacity are to be solved. The concluding chapter attempts to formulate a program for providing this control but is unconvincing and is the weakest chapter in the book.

This study is a distinct contribution and raises problems that merit careful consideration. It is, however, too detailed and technical to be of interest except to the specialist in the field.

J. F. BOGARDUS

EARLY VIEWS OF AMERICAN CITIES

I. N. PHELPS STOKES AND DANIEL C. HASKELL. **American Historical Prints: Early Views of American Cities, etc. From the Phelps Stokes and Other Collections.** xxxvi and 327 pp.; 118 plates; maps, diagr., ills., indexes. New York Public Library, New York, 1932. $25.00. 11¼ x 8½ inches.

The printed record of past events has come down to us in far more complete form than the pictorial and cartographic record of the scenes amidst which the events occurred. Boston was settled in 1630, and Harvard College founded in 1636; but the earliest known views of Boston and of Harvard date from nearly a century later. We know what has happened in the political and social life of our cities year by year, month by month, almost day by day, from the beginning; but what these cities have looked like we know only for scattered dates between which there are often wide gaps, particularly during the early period. To draw a view or a map requires special skill, and such documents are not so readily copied and preserved as printed matter. Yet the graphic record is an important source of historical information. The aspect of the towns that man builds is surely one expression

of the quality of his civilization, and the changing cultural landscapes amidst which he dwells are not without influence upon his character and his outlook.

The volume under review is the catalogue of a collection of early maps, plans, and views recently presented to the New York Public Library by Mr. I. N. Phelps Stokes. Most of the items illustrate American cities and towns in the seventeenth, eighteenth, and early nineteenth centuries. For many years Mr. Stokes has been gathering material concerning New York City. The results of his studies in this field are set forth in one of the most sumptuous publications ever produced in the United States, "The Iconography of Manhattan Island," in five volumes. The present collection is largely an outgrowth of this more specialized interest, and in the new catalogue the high standards set in the "Iconography" are maintained. To the zeal of the collector has been added the fortunate combination of learning, a sense of relative values, and good taste. Those who appreciate fine workmanship in the making of books will rejoice in this volume.

Mr. Phelps Stokes's plan has been to bring together "a really comprehensive and representative selection of views of those towns and cities in the Western Hemisphere which, individually, have made the greatest contribution to its development, or which are the most characteristic of important phases of that development, due consideration being given to geographical distribution and to early settlement, as well as to later historical importance." A list of 160 towns in the United States and of 40 elsewhere was drawn up, and for most of these places at least one map or view of historical value was obtained. The catalogue gives a full account of each item in the collection, not only those details of a bibliographical nature that are of interest primarily to collectors but also brief explanations of what each item actually shows. In addition, the catalogue itself is illustrated with reproductions of the more important maps, plans, and views.

For the larger cities maps and panoramic views of successive dates show how the layout of streets, parks, wharves, and built-up areas has evolved. Views of buildings and street scenes disclose varying types of architecture region by region and from period to period. An unusually beautiful view of an unidentified city piques the curiosity. A catalogue is generally rather dull and workaday, but this one is a thing of charm.

Chronology of Human Cultures

Miles Burkitt and V. Gordon Childe. **A Chronological Table of Prehistory.** Maps, index. *Antiquity*, Vol. 6, 1932, pp. 185–205. Table as Supplement.

The growth of knowledge of antiquity in the last fifteen years, in which the authors have played a valuable part, is making it possible for the eye of faith to see that some day the divergence of human races, the spread of human cultures, and the evolution of human societies will be visualized as varied aspects of the same process. The day for such a sketch has not yet arrived, but it is possible to make a tentative scheme of parallels of culture in various regions and times that raises controversies, if at all, only over details. The chart under review attempts no estimate of time for the Paleolithic Age but surveys it very reasonably for the northwestern quadrant of the Old World, adopting a fair hypothesis as to relations with the phases of the Pleistocene ice ages. The authors have clearly adopted the view that what may be called epipaleolithic cultures persisted in Europe until agriculture was introduced; i.e., the old fancy of an immense European Neolithic period, in which pastoralists from Asia spread as nomads over Europe, has disappeared, and the chart with its left-hand columns discussing the Near East allows the reader to get an idea of the spreads of culture, mainly from that area. The chart may be recommended to the general student, especially if he can have at hand some general textbook of archeology as a guide and check. It is most significant that dating from 3000 B.C.

onwards, even in Europe, is coming to be a matter in which estimates often agree to a century or so; and those adopted in this chart are likely to stand with modifications of this magnitude here and there.

H. J. FLEURE

AIR NAVIGATION

BRADLEY JONES. **Avigation.** ix and 314 pp.; maps, diagrs., ills., index. John Wiley & Sons, New York; Chapman & Hall, London, 1931. $2.75. 7¾ x 5¼ inches.

P. V. H. WEEMS. **Air Navigation.** xiii and 589 pp.; maps, diagrs., ills., bibliogr., index. McGraw-Hill Book Company, New York and London, 1931. $5.00. 9 x 6¼ inches.

These two books on air navigation, or avigation as it is now called, differ from most already published in America on the subject in the stress laid on a knowledge of meteorology, astronomical position-finding, and mathematical geography in the training of avigators.

Mr. Bradley Jones's book is clearly and concisely written, and in order to emphasize the fundamental principles much extraneous material is omitted which, of interest perhaps to the scholar, is likely to confuse the novice. The book has numerous worked-out examples and a set of problems at the end.

A misstatement occurs on page 114 in connection with the taking of cross bearings. It is stated: "If the bearing lines plotted from three objects do not intersect in a point, they form a small triangle. This is called a *cocked hat*, and the center of the cocked hat is the position of the aircraft." This of course is true only in rare cases even when the observer's position is inside the triangle formed by the lines joining the three points observed.

Lieutenant Commander Weems's book covers much the same ground, but it is more detailed in its description of equipment, instruments, and diversity of method. The author treats his subject in a much more personal way, which, though making the book entertaining, increases its bulk considerably; and, if Mr. Bradley Jones's book is to be criticized for its brevity, Lieutenant Commander Weems's book must be criticized for its length. Nevertheless, apart from the anecdotes, it contains a wealth of material not heretofore brought together.

As regards the treatment of the astronomical side of avigation, Lieutenant Commander Weems naturally devotes most space to the methods and devices for which he is partly or wholly responsible, such as the "second setting watch," the "line of position book," and the use of star altitude curves. However, there is also a whole chapter devoted to "Avigation by precomputed altitudes," which method does away entirely with any computing during flight and is approximately the method used by Post and Gatty in their round-the-world flight.

Excellent chapters are included on map reading and handling maps in the air, airways, radio aids to avigation, theoretical and applied aërology, and blind flying. And there is an extensive bibliography.

The book is not entirely free from technical errors. On page 20 the graphical construction described for drawing a Mercator's projection would actually produce a perspective projection on a tangent cylinder, not by any means the same thing.

Both books are in their own ways valuable contributions to the literature of the subject.

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